OPERATING AND SERVICE MANUAL

1200
PORTABLE DIGITAL
STRAIN INDICATOR

MP MASTER
MA24949

BLH ELECTRONICS, INC.

WALTHAM, MASSACHUSETTS 02154 • (617) 894-6700

TM·1200·1

BLH MANUAL CHANGES

MODEL 1200

MANUAL TITLE Portable Digital Strain Indicator

MANUAL PREFIX TM-1200-1

MAKE ALL CHANGES IN THIS MANUAL ACCORDING TO ERRATA AND CHANGE(S) LISTED BELOW

Change 1: Four phillips-head front panel retaining screws have been added for additional security. These screws must be unfastened in order to remove the instrument chassis from the case. Replace Paragraph 5-9, Section V of the manual with the following Paragraph - and replace Figure 5-2, Chassis Removal with the attached illustration.

5-9. Refer to Figure 5-2 and remove the chassis as follows:

a. Unplug instrument and unlatch and remove front cover (see paragraph 5-6).

b. Locate and remove the two 6-32 x 3/8 rear panel power supply retaining screws.

c. Locate and remove four phillips-head front panel retaining screws.

d. Withdraw power supply by pulling it directly to the rear as shown. If power supply does not move easily, rock it gently from side to side while pulling rearward. (See Figure 5-5 and 5-6 for location of Power Supply components).

e. When the power supply is removed, four chassis retaining screws are exposed. Remove.

f. Grasp front panel of indicator and withdraw chassis directly to the front as shown.

12-12-72
DATE

TME-1200-1-2
CHANGE NUMBER

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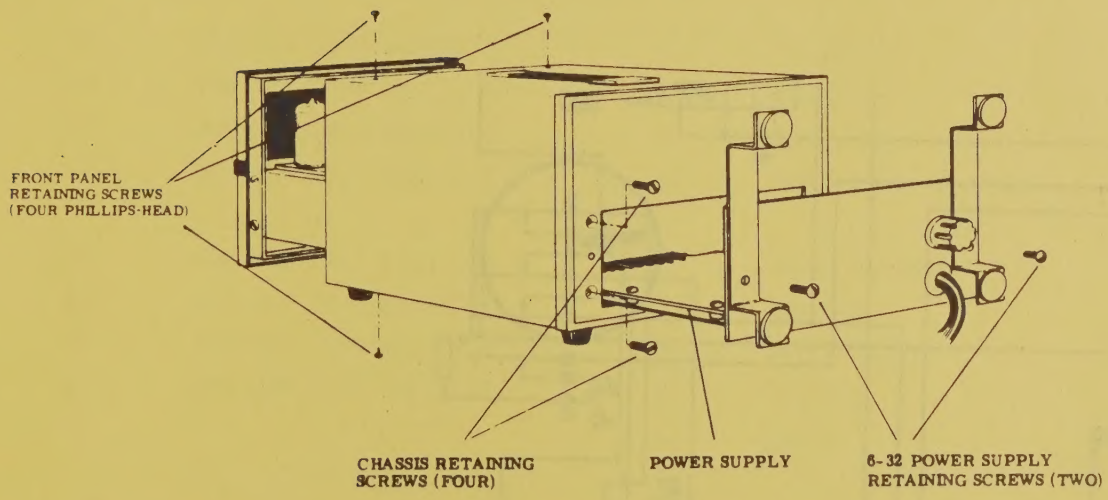

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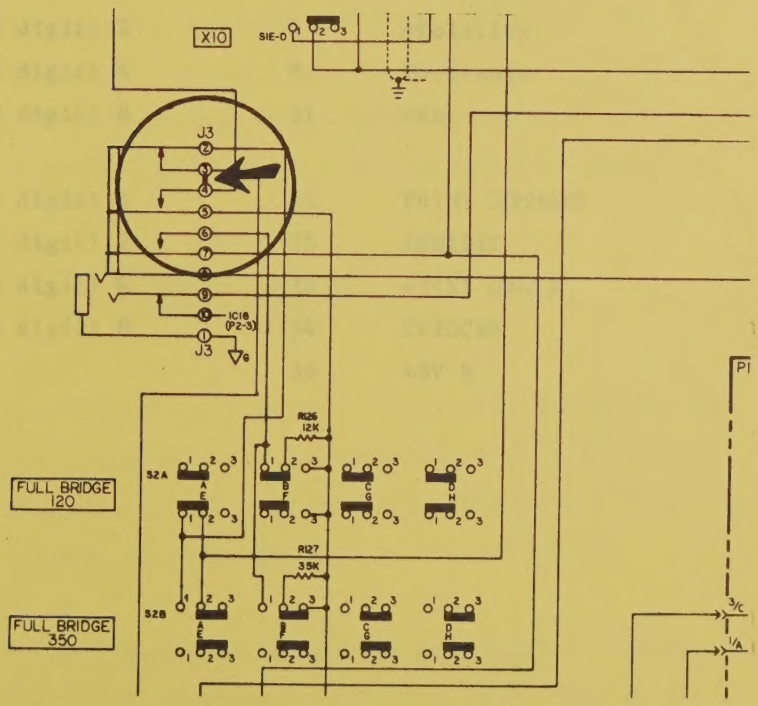
ERRATA: Schematic Diagram (rear of manual). Terminals (3) and (4) of the DYN OUT jack, J3, should be shown jumpered as indicated on the reproduced portion of the schematic below.



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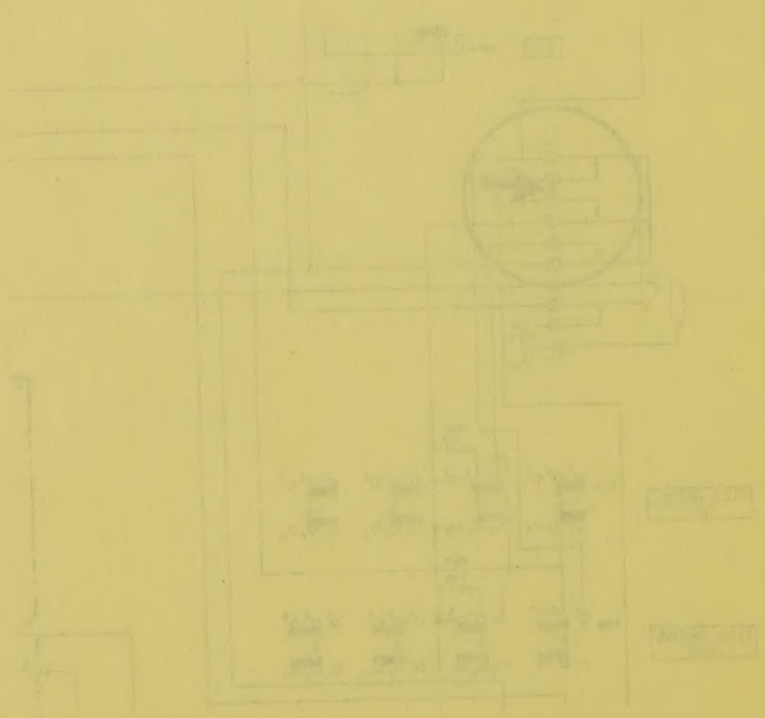

MODEL 1200

OPTION 03 BCD OUTPUT

When Option 03, BCD OUTPUT, is specified, the instrument is equipped with a 37-pin rear panel connector designed J9. BCD OUTPUT is as follows:

PIN	FUNCTION	PIN	FUNCTION
9	BCD OUT (1st digit) 1	26	BCD OUT (4th digit) 1
12	BCD OUT (1st digit) 2 (MSD)	27	BCD OUT (4th digit) 2 (LSD)
13	BCD OUT (1st digit) 4	28	BCD OUT (4th digit) 4
14	BCD OUT (1st digit) 8	29	BCD OUT (4th digit) 8
15	BCD OUT (2nd digit) 1	3	-Polarity
16	BCD OUT (2nd digit) 2	4	+Polarity
17	BCD OUT (2nd digit) 4	8	Overrange
18	BCD OUT (2nd digit) 8	31	GRD
19	BCD OUT (3rd digit) 1	22	PRINT COMMAND
20	BCD OUT (3rd digit) 2	35	INHIBIT
24	BCD OUT (3rd digit) 4	32	+5(X1 ONLY)
25	BCD OUT (3rd digit) 8	34	TRIGGER
		36	+5V B

BLH ELECTRONICS, INC.

TECHNICAL MANUAL
MODIFICATION, CHANGE, SUPPLEMENTAL INFORMATION

DYNAMIC OUTPUT OPERATION

When the dynamic output jack is used to monitor fluctuating or rapidly oscillating output signals, full scale output (10,000 micro-inches-per-inch of strain) is equivalent to 1 volt at the jack.

When the plug (H. H. Smith 3-conductor #308, 309, 311, 312 - see illustration) is inserted at the DYN OUT jack, the auto-zero circuit is automa tically disconnected at the preamplifier. The digital display is no longer relevant and cannot be used to monitor strain when the DYN OUT jack is being used. In addition, the GAGE FACTOR controls will have no effect on the digital display.

Dynamic transducer output can also be monitored at the DYN OUT jack. A transducer output of 1 mv/v is equivalent to 2000 micro-inches per inch of strain or 0.2 V at the DYN OUT jack; 2 mV/V is equivalent to 1000 microinches per inch or 0.4 v, etc.

With zero load on the transducer, or strain gage bridge, output should be less than 0.1V. If unloaded output is more than 0.1V, adjust with internal control R119 (see step 9 of calibration procedure Paragraph 5-15). Output impedance at the DYN OUT jack is less than 10Ω.

OPERATING AND SERVICE MANUAL

1200
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STRAIN INDICATOR

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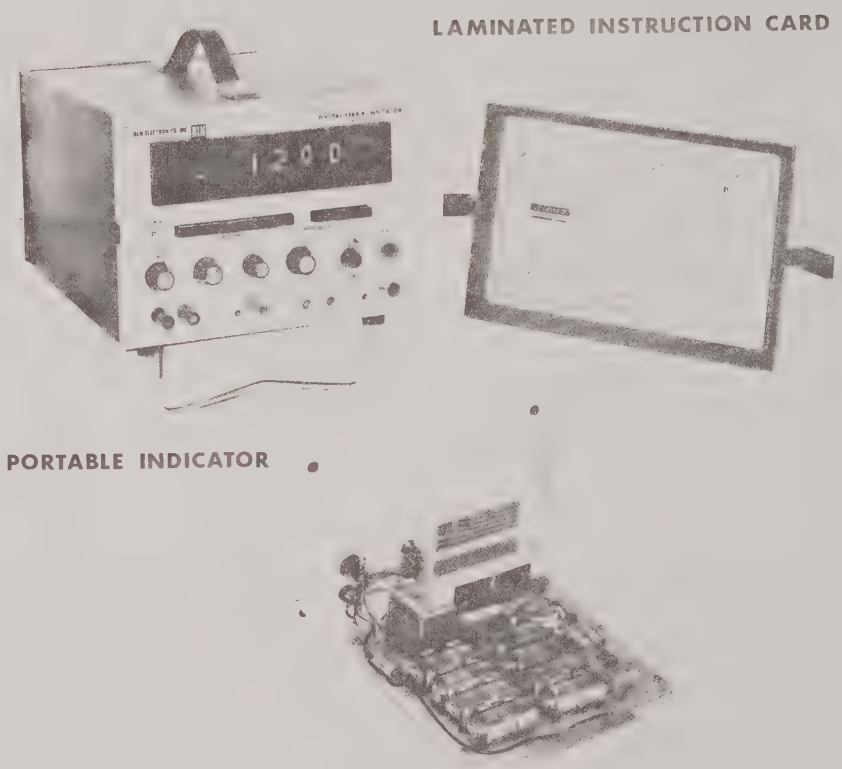


Figure 1-1. Model 1200 Portable Digital Strain Indicator

SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. General.

1-3. The BLH Model 1200 Portable Digital Strain Indicator, Figure 1-1, is designed to amplify, measure, and display the millivolt per volt output of wire and foil strain gages in microinches per inch.

1-4. The instrument generates a regulated bridge excitation voltage of approximately 4.8V and will accommodate a 1/4, 1/2, or full bridge configuration. Gages with resistances of 120Ω or 350Ω (1/4 bridge configurations) and from 60 to 2000Ω (1/2 and full bridges) can be used with the instrument. Gage factor range is 0.5 to 9.500. Readout is instantaneous and is displayed in four digits on miniature-glow discharge tubes. An automatic, non-blinking polarity indicator is located to the left of the most significant digit. Drift caused by ambient temperature variations is automatically eliminated with an integral auto-zero circuit.

1-5. Description.

1-6. The Model 1200 is completely self-contained in a 9-7/8 x 7-5/16 x 14-1/4 inch vinyl-covered aluminum case; weight is approximately 9-1/2 lbs. Solid-state modular IC construction has been used throughout. The modular concept simplifies troubleshooting and maintenance and insures long trouble-free operation.

1-7. CONTROLS. All controls are functionally grouped on the front panel of the instrument. A grouping of three pushbuttons allows the instrument to be accurately set for the correct bridge configuration in use. Initial gage bridge unbalance is cancelled with the COARSE and FINE BRIDGE BALANCE controls. The approximate gage factor of the gages in use is set into the instrument with the COARSE GAGE FACTOR switch. Exact setting is dialed in with the FINE GAGE FACTOR control, and is displayed in the digital readout when the GF ADJ pushbutton is depressed. Gages are connected to the color coded three way terminal posts.

1-9. IDENTIFICATION.

1-10. The 1200 is supplied with any or all of the following options.

01 Model 1200 with 115/230Vac Power Supply.
02 Model 1200 with Rechargeable Battery Pack (115/230Vac Recharging Circuit).
03 Model 1200 With BCD Output.

Serial numbers identifying the basic instrument and the power supply in use are engraved on a metal plate at the rear of the instrument and inside the power supply.

1-11. The indicator can be used in field or laboratory applications depending upon the model ordered. The battery operated 1200 is a rechargeable unit suitable for short run laboratory tests or field use. The ac operated unit (Option 01) is designed primarily for laboratory use. This version can easily be converted to battery operation with Option 02. Option 01 is also used to convert the battery model to ac operation. Complete conversion instructions are included in Section II of this manual. The BCD output connector, (Option 03) when supplied, is mounted on the rear panel of the instrument.

1-12. Two pushbutton switches are provided to check the optional battery pack. Level of charge is indicated in the digital display. A reading below 4100 when either battery check switch is pressed indicates the batteries should be recharged. A battery saver READ switch applies bridge power to the gages for a maximum time of at least 15 seconds depending upon the setting of the DISPLAY TIME switch. Bridge power is automatically shut off at the end of the selected time. A dynamic output oscilloscope jack (for monitoring oscillating signals) and a bridge POWER indicator light complete the control panel layout.

1-12. Specifications.

1-13. Specifications which apply to the Model 1200 are listed in Table 1-1. Power supply specifications for both units are also listed in Table 1-1.

1-14. Other Information.

1-15. Although designed primarily for use with wire and foil strain gages, the indicator can be used to measure the mV/V output of a single wire or foil strain gage transducer. Semi-conductor strain gages can not be used with the indicator. Semi-conductor gage readings can, however, be measured on a special BLH designed indicator. The indicator is not offered for sale but can be easily constructed for approximately $70.00 by a competent technician using off-the-shelf components.

The indicator permits the user to obtain all information needed for accurate data reduction, test for gage dioding, and check for leakage to ground. In a portable version, it is a reliable, accurate piece of field equipment. Instructions, plans, and a bill of materials for the instrument is included in Section VII of the Semi-Conductor Strain Gage Handbook. Copies will be supplied, free of charge, on request.

1-16. Options and Accessories.

1-17. Both the ac and battery power packs are interchangeable. Either can be supplied as an option to increase the versatility of the instrument. An extender board, useful for troubleshooting and checking the power supplies, is also available as an accessory. The Model 625 Calibrator is essential for troubleshooting and calibration.

Table 1-1. Specifications

INPUT

Bridge Configuration:	120Ω and 350Ω ¼ bridge; 60 to 2000Ω half bridge and full bridge.

OUTPUT

Strain Range (X1):	0 to ± 10,000 microinches per inch (1 microinch per inch resolution). Overranges to ± 19,999 microinches per inch for Gage Factor settings of 0.500 to 5.000. Decreases linearly from maximum of ± 19,999 to maximum of ± 10,000 microinches per inch for Gage Factor settings of 5.000 to 10.000.
(X10):	0 to ± 100,000 microinches per inch (10 microinches per inch resolution). Overranges to ± 199,990 microinches per inch for Gage Factor settings of 0.500 to 5.000. Decreases linearly from maximum of ± 199,990 to maximum of ± 100,000 microinches per inch for Gage Factor settings of 5.000 to 10.000.
Dynamic Output:	Approximately ± 1.000 volts out for ± 10,000 microinches per inch with one active gage with a Gage Factor of 2.000 at a bridge excitation voltage of 5.0 volts. Dynamic output is independent of instrument Gage Factor setting and proportional to the negative battery voltage when operated with the battery pack. Maximum dynamic output is ± 5 volts at 1 milliamp. Recommended for use with ac power supply only.
Output Impedance:	Less than 10Ω.
Frequency Response:	Flat ± 10% to 50KHz.
Slew Rate:	Approximately 300 mV/μ second.
Noise:	10 mV peak-to-peak with ac power supply.
Auto Zero:	Inserting the scope jack for dynamic output disconnects the auto zero on the preamplifier.
Amplifier Offset:	Less than 0.1V.
Digital Outputs: (Option 03)	5 BCD 1-2-4-8 digits plus single bit polarity.
Logic Levels and Currents (Standard TTL):	Logic "1": +2.4V min. Logic "0": +0.4 max. All digital output signals are capable of sinking 8mA at lower logic level and sourcing 0.2mA at upper logic level.
Data Ready Signal:	Upper level (+2.4V min.) to lower level (+0.2V max.) transition with output returned to upper level exponentially in 12μ seconds (nom.).

PERFORMANCE

Sample Rate:	2 readings per second.
Auto Zero:	Automatic electronic zero correction is employed.
Linearity:	± 0.04% of reading, ± 1 digit (Full Bridge, 4 active gages).

DISPLAY

Readout:	Five 0.5"H miniature gas discharge tubes.
Polarity:	Automatic with + and − polarity indicators.

PHYSICAL

Size:	9⅞" W x 7⅝" H x 14¼" D (with cover).
Weight:	12.4 lbs. for ac version (with cover), 12.9 lbs. for dc version (with cover).

CONTROLS

Gage Factor Adjustment:	Coarse ten-position switch plus ten-turn potentiometer for fine adjustment. Total gage factor range: 0.500 to 9.500 with resolution of 0.001. The GF setting is displayed on the digital readout when Gage Factor pushbutton is depressed.
Bridge Zero Adjustment Range	
Static Mode:	± 5000 microinches per inch at Gage Factor of 2 for ¼ and ½ bridge positions on both X1 and X10 positions. ± 5000 microinches per inch on FULL BRIDGE position in X1 position. ± 50,000 microinches per inch on Full Bridge position in X10 position. Adjustment is an integral part of the amplifier circuit and therefore, does not load the output of the bridge.
Dynamic Mode:	± 5000 microinches per inch at Gage Factor of 2 for ¼ or ½ bridge or 120 or 350 full bridge. Adjustment is a standard "T" network on bridge output. Range is inversely proportional to gage factor setting.
Battery Check:	Two pushbuttons are provided to check the batteries. The actual charge state on the batteries is indicated on the digital display. A reading below ± 4100 indicates that the batteries should be recharged.

TEMPERATURE

T.E. on Zero:	± 0.005% of range/°F (± 0.01⅑°C)
T.E. on Span:	± 0.005% of range/°F (± 0.01%/°C).
Operating Temperature Range:	32 to 130°F (0-55°C)

POWER

Power Requiements:	115/230VAC ± 10%, 50 to 400 Hz or internal rechargeable battery pack. To order, specify Part No. 415630 for Model 1200 w/o power source. For ac power source, order Option 01, Part No. 415599. For rechargeable battery pack, order Option 02, Part No. 416176. Power sources above are plug-in modules and are interchangeable.
Battery Pack:	Eight 1.2V rechargeable nickel cadmium batteries. Four batteries form a +4.8V supply for the digital logic supply and four batteries form a −4.8V supply for bridge power. A dc to dc converter operating from the ±4.8V supplies produces +180V for the digital display and ±12V supply for analog circuits.
Battery Life:	One hour continuous duty, considerably longer when using self-contained battery saver circuit. Batteries can be charged in excess of 200 times.
Battery Saver Circuit:	Bridge power is turned on by the switch on the Display Time Control. All other power remains off until the READ button is pressed. Pressing the READ button energizes the display and allows a maximum digital display time of at least 15 seconds, depending upon the setting of the DISPLAY TIME control.

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information on unpacking, inspection, repacking, and installation.

2-3. INITIAL INSPECTION.

2-4. Mechanical Inspection.

2-5. If external damage to the shipping carton is evident, ask the carrier's agent to be present when the instrument is unpacked. Check the unit for external damage such as broken controls or connectors, and dents or scratches on the panel surface. If damage is found, refer to Paragraph 2-8 for recommended claim procedure and repacking information. If the shipping carton is not damaged, check the cushioning material and note any signs of severe stress as an indication of rough handling in transit. Retain the packaging material for possible future use.

2-6. Electrical Check.

2-7. Check the electrical performance of the instrument as soon as possible after receipt; see Figure 2-11, for recommended calibration checks. This check is a good test procedure for incoming quality control inspection and for an operational check after repairs or adjustments have been made.

2-8. CLAIMS AND REPACKING.

2-9. Claims for Damage.

2-10. If physical damage is evident or if the instrument does not meet specifications when received, notify the carrier and the nearest BLH Sales/Service Office. The Sales/Service Office will arrange for repair or replacement of the unit without waiting for settlement of the claim against the carrier.

2-11. Repacking for Shipment or Storage.

2-12. If the instrument is to be shipped to a BLH Sales/Service Office, or to the factory, attach a tag showing owner, address, instrument model and serial number, and the repair required. The original shipping carton and packaging material may be reusable. The BLH Sales/Service Office will also provide information and recommendations on materials to be used if the original packaging material is not available or not reusable. Materials should include, (1) a double-walled carton (check with a freight carrier for test strength required), (2) heavy paper or sheets of cardboard to protect all instrument surfaces; use extra material around projecting parts of the instrument, (3) at least four inches of tightly packed, shock absorbing material surrounding the instrument. Close the package securely with heavy paper tape.

2-13. INSTALLATION.

2-14. Location.

2-15. The indicator will operate satisfactorily between + 32 °F and +130 °F (0 °C and 55 °C) in most enviornments. For best operation, however, avoid locations where the instrument will be subjected to temperatures above 110 °F or below 32 °F. The instrument should not be located in areas containing explosive or corrosive vapors or in the vicinity of strong magnetic fields(e.g. large power transmission cables, welding equipment, high voltage transformers).

2-16. Power Cable.

2-17. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. Both the ac and battery operated models of the instrument are equipped with a 10-foot, 3-conductor power cable; the third conductor is the ground conductor, and when the instrument is plugged into an appropriate receptacle, the instrument is grounded. The offset pin on the power cable three-prong connector is the ground connection.

2-18. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter, and connect the green lead on the adapter to ground.

2-19. Power Requirements.

2-20. The ac version of the indicator is designed to operate at either 115 or 230Vac at 50 -400 Hz. The battery operated version is supplied with eight 1.2 V rechargeable nickel-cadmium batteries. Four of these are used as a digital logic supply. The remaining four , in conjunction with the power supply circuit, apply a regulated excitation voltage to the strain gage bridge.

2-21. LINE VOLTAGE SWITCH. A two-position slide switch located on the rear of the instrument controls input transformer connections. The number visible on the slider of the switch indicates the line voltage for which the primary windings are connected. Check that the designation on the slide switch matches the nominal voltage of the power source before plugging in the instruments: if not, slide the switch to the other position.

2-22. A dc to ac converter operating from the ± 4.8V power supplies produces +160V, unregulated, to power the readout tubes. In addition, ±12V is produced for the analog circuits.

2-23. The batteries are checked with the BATTERY CK 1 and CK 2 pushbutton switches on the front panel of the instrument. A reading of 4100 or below in either switch position indicates that the batteries should be recharged.

2-24. The batteries are recharged by plugging the battery pack into a 115 or 230 Vac outlet and pressing the BATTERY CHG button (check that 115/230 slide switch at rear of battery pack is positioned correctly). It is not necessary to remove the battery pack from the instrument when recharging. Recharging time will vary depending upon the level of charge remaining. Eight hours is usually sufficient.

IMPORTANT

The battery pack cannot be recharged during instrument operation. Gage readings taken during recharging will be invalid and should not be attempted.

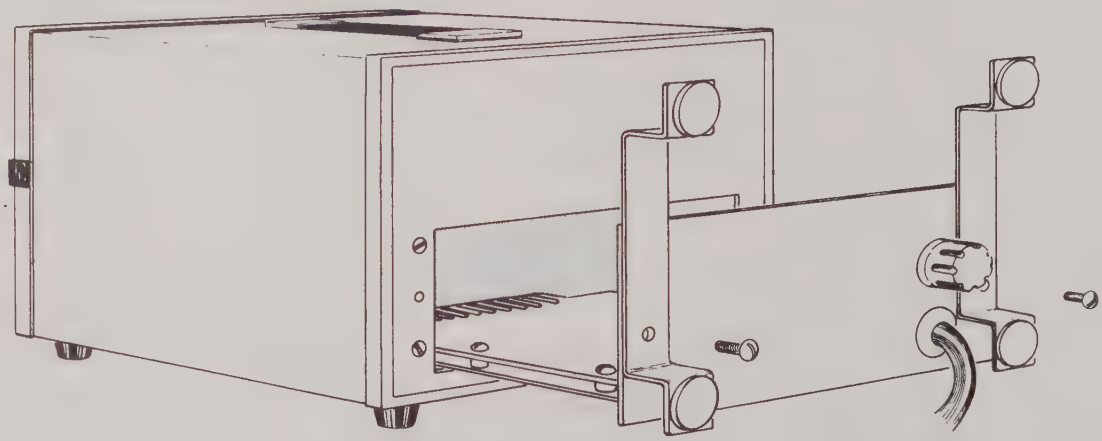
2-25. Battery life is approximately one hour under continuous service. The battery saver circuit, however, allows considerably longer life. When bridge power is applied to the gages with the DISPLAY TIME switch, all other power remains off until the PUSH TO READ button is pressed. This energizes a circuit which will allow the indicator to display the reading for only the time span set into the circuit with the DISPLAY TIME switch.

2-26. Power Supply Conversion.

2-27. The ac and battery pack power supply modules are interchangeable without modification. Refer to Figure 2-1 for conversion instructions.

2-28. Mounting.

2-29. The 1200 is designed primarily for bench top operation but will function normally in any position. The instrument is equipped with non-skid neoprene pads for horizontal or vertical use. A tilt bail is provided for ease of operation in the horizontal position. See Figure 2-2.



(1) Unplug instrument.

(2) Locate and remove the two rear panel power supply retaining screws.

(3) Withdraw power supply by pulling it directly to the rear as shown. If power supply does not move easily, rock it gently from side to side while pulling rearward.

(4) Plug in conversion unit firmly. Make sure edge connector engages in receptacle and secure unit with the two retaining screws.

Figure 2-1. Power Supply Conversion

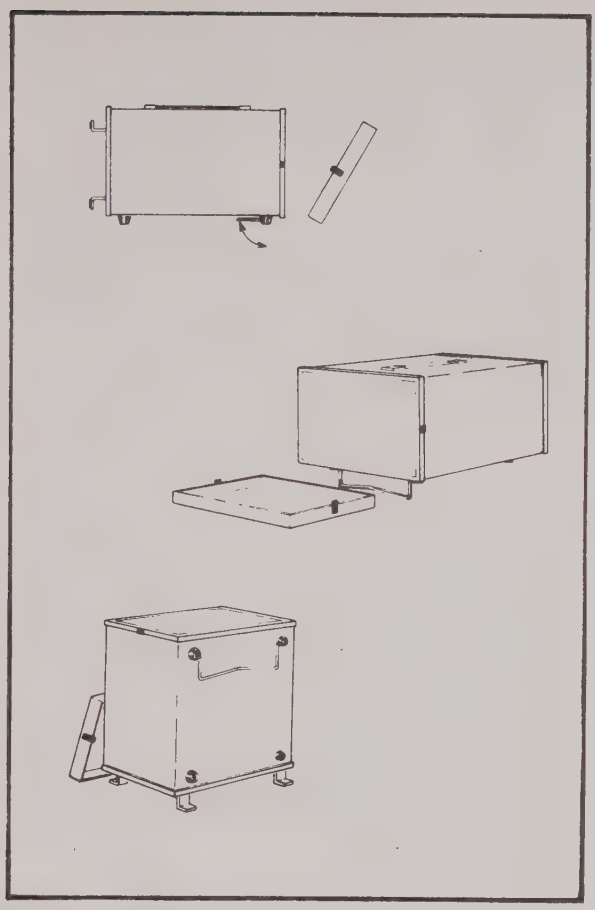


Figure 2-2. Mounting.

2-30. STRAIN GAGE CONNECTION DATA.

2-31. General.

2-32. Strain gages are connected to the indicator with extension lead wires. Installation of these wires is critical and must be done very carefully. Gravity, thermal and mechanical shock, or careless handling can ruin a gage installation by transmitting these forces to the sensing element through the lead wires.

2-33. To reduce this risk, a small terminal strip is mounted at a location near the gage installation. The intermediate gage leads are then connected between the terminal strip and the indicator. Several kinds of terminals are available for this purpose. Proper installation techniques for each are detailed in the BLH Strain Gage Handbook, available to users at no cost. Some general guidelines are presented in the following paragraphs. See Figure 2-3 for a typical installation.

2-34. Methods of Attachment.

2-35. There are two primary methods of attaching lead wires to the terminal strip; soldering or welding. Soldering is the most popular and most widely used. For most strain gage work, the solder used should be 60-40 tin-lead. This solder has a melting point of 360°F and mechanical strength is generally good. Wetting and flow characteristics are very good on most metals.

2-36. The low-temperature performance of tin-lead solders, however, is very poor. The alloy becomes brittle at temperatures below 0°F because of tin content. This will weaken the connection drastically and is, therefore, unsuitable for cryogenic applications. Lead-tin-silver combinations are more suited to low temperature installations, straight tin-silver alloys being preferred for high temperature work to about 425°F.

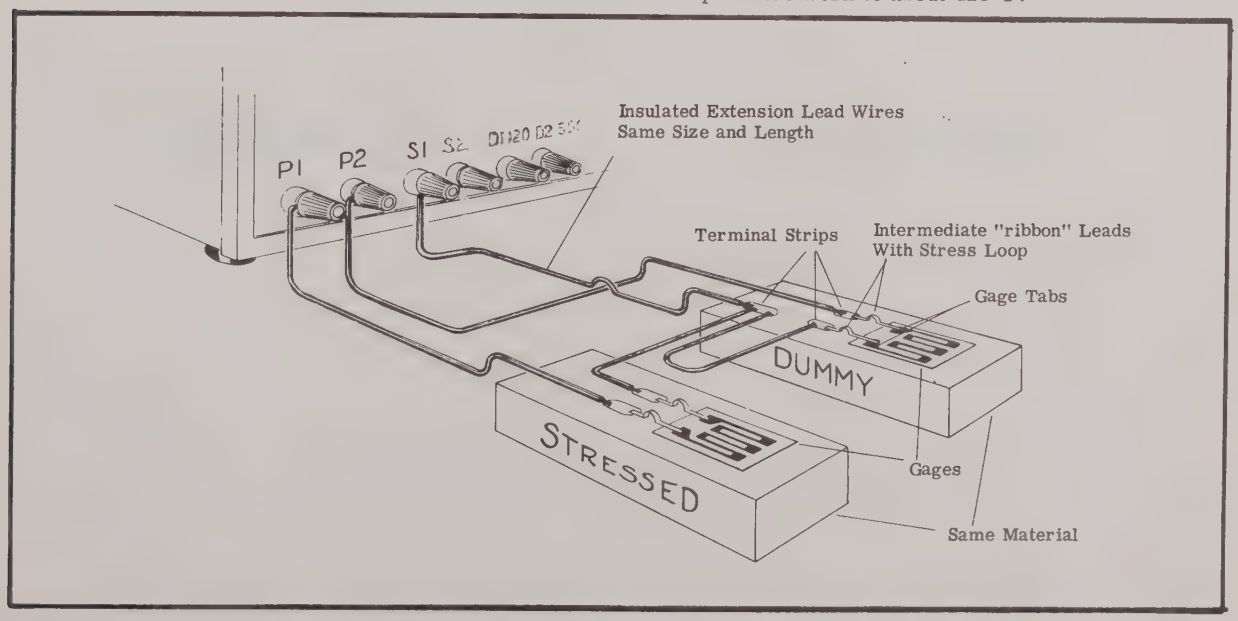


Figure 2-3. Typical Half-Bridge Installation.

2-37. Non-corrosive flux is recommended where ever possible. On most metals, a pure rosin flux will provide a clean, tarnish-free surface during soldering and will insure proper wetting of the surface. For stainless steel and other metals difficult to solder, an organic flux should be used. In these cases it is imperative that all traces of the flux be washed away after soldering. Corrosive flux left on the terminals will cause corrosion and leakage to ground problems resulting in erratic readings.

2-38. Welded joints are usually employed in installations where the operating temperature is too high for soldered connections. In such installations, weldable terminals TB-550 or TC-1200 are recommended for use as junction points between the gage leads and the main lead system to prevent gage damage. See the Strain Gage Handbook for special precautions and specific welding techniques.

2-39. Temperature Effects on Lead Wires.

2-40. When half and full bridge configurations are connected to the instrument as shown in the diagrams, resistance changes in the lead wires caused by temperature variations are eliminated. Note that wires must be of the same length and located sufficiently close together to insure self-cancellation of temperature induced resistance changes.

2-41. Quarter bridge (single gage) configurations, however, will be affected if the extension leads are long and terminal S2 is connected to D1 or D2 with a short length of lead wire as shown in Figure 2-4. Essentially, this would be a two-wire system.

2-42. To compensate for possible temperature effects, connect a third lead wire between Terminal D1 or D2 and the gage rather than directly to S2 as shown in Figure 2-5. The third lead wire must be of the same size and length as the other two in order to be effective.

2-43. Strain Gage Extension Leads.

2-44. Gage lead extension wires should be soldered or welded to the gages depending upon the application and type of gage used as described in the preceding paragraphs. For binding post connections at the instrument, lead extensions should be soldered to clean, tinned spade lugs. If stranded lead-wire is used, all strands should be intact and care should be taken to solder all strands to the spade lug. In locations where strong electrical disturbances are present, shielded cable should be used for long extension leads. The shield should be grounded at only one point. See Strain Gage Handbook for other lead wire considerations.

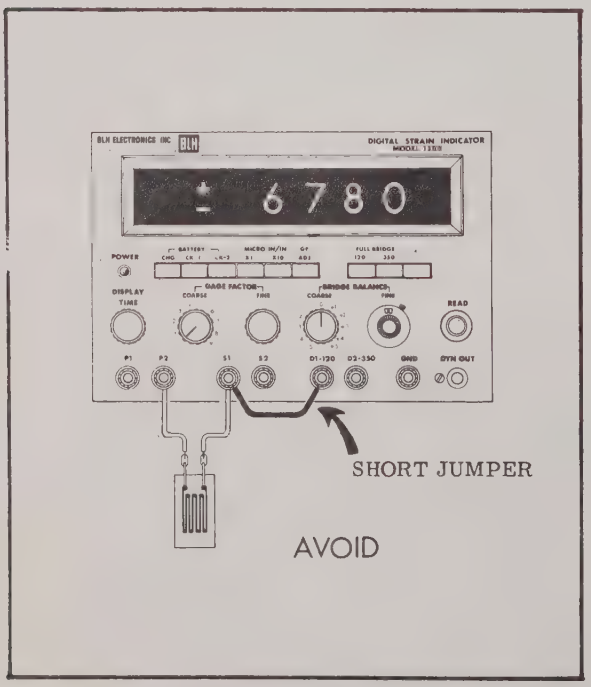


Figure 2-4. Quarter Bridge

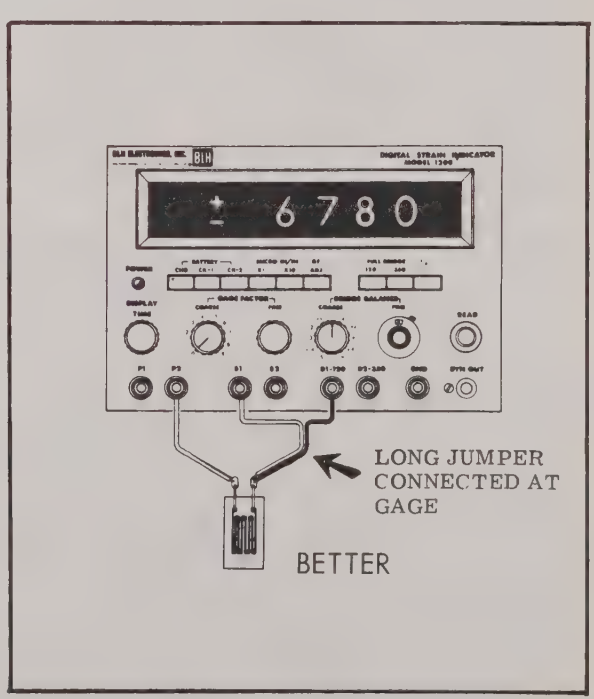


Figure 2-5. Quarter bridge

2-45. Lead Wire Resistance.

2-46. In most applications the effect of lead wire resistance on strain measurements will be negligible. When long or small diameter leads are used, however, the added resistance of the leads, in series with the strain gage, reduces the effective gage factor in proportion to the ratio of lead wire to gage resistance. Resetting the gage factor control will correct measurement errors introduced by load wire resistance. To illustrate, assume that a 120Ω gage is connected to the Indicator by two 75-foot leads of #20 AWG copper wire. Number 20 copper wire has an approximate resistance of 10 ohms per 1000 feet; The total lead wire resistance in series with the gage will, therefore, be 1.5Ω, which will reduce the effective gage factor by the ratio of 1.5:120 or 1.25 percent. The correction is made by setting the instrument gage factor control 1.25 percent low or at 98.75 percent of the value marked on the gage package. An alternative method would be to set the conditioner to the gage factor marked on the package, and multiply all measured strains by 1/0.9875.

2-47. Temperature Effect on Lead Wire.

2-48. Table 2-1 is a general listing of locally obtainable materials that have been found suitable for BLH strain gage use. For other than BLH strain gage use, consult the manufacturer. Table 2-2, Lead Wire Selection Chart, is a complete coded listing with appropriate catalog number of lead wire and cable stocked by BLH. These materials are available through any of the BLH Sales/Service Offices listed at the rear of this manual or directly from the factory.

Table 2-1. Gage Lead Conductors and Insulators

CONDUCTORS	Operating Temperature °F	
	Stable To	Maximum
Nickel Clad Copper	700	1000
S. S. Clad Copper	800	1300
Nickel Clad Silver	1000	1500
Nichrome	700	1700

INSULATORS	Temperature Range °F	
	From	To
Nylon	Below -100	250
Nylon, Vinyl	-100	150
Nylon, Polyethylene	-100	200
Teflon	-100	500
Glass Impregnated Sl.	Above 500	600+*
Glass Sleeving	Above 500	600+

*Electrical insulation breakdown varies with the glass used. Exercise caution when selecting glass for use above 600° F.

2-49. Other Sources of Signal Error.

2-50. In addition to the temperature and lead wire resistance effects noted in the preceding paragraphs, signal errors can also be caused by mechanical stresses in lead wires and by gage overheating.

2-51. MECHANICAL STRESSES. It is possible for stresses produced in lead wires by their own weight to influence the output signal of the gage bridge. Tie down long leads and provide strain reliefs wherever possible.

2-52. GAGE OVERHEATING. If the gages are mounted on a poor heat sink, plastics for example, the current flowing through the gage may cause overheating of the filament. This can influence the signal output. This condition can be alleviated by applying excitation to the gages only when a reading is to be taken or by reducing excitation voltage.

2-53. SPECIFIC APPLICATIONS.

2-54. Three-Wire Half-Bridge.

2-55. To cancel the effects of temperature on the gage, a circuit like that shown in Figure 2-6 is used. The measuring or "active" gage is mounted on the test specimen and the compensating or "dummy" gage is mounted on an unstressed piece of the same material. Both gages are subjected to the same changes in temperature during the course of measurement. Resistance changes due to temperature alone will be the same for both of the Wheatstone bridge arms in which these gages are located (the remaining two arms are located within the instrument and will not affect the stress-induced strain at the measuring gage). Connect the gages to the instrument as shown in Figure 2-6. Two common types of half bridge are shown. Each, however, is essentially the the same. See Figure 3-1 for operating instructions.

2-56. Four Arm.

2-57. In the four-arm (full bridge) configuration, four strain gages are connected in the form of a Wheatstone bridge, in which any or all of the gages may be active. This particular arrangement has been used effectively where strains to be measured are very small. In operation, the bridge is unbalanced in proportion to the difference in the strains of active gages located in adjacent arms and in proportion to the sum of the strains of active gages located in opposite arms.

2-58. If the four-arm bridge is used with the Model 1200 connect the two input voltage leads to the Black and Green terminals. Connect the gage bridge signal output leads to the Red and White front panel terminals S1 and S2(+). See Figure 2-7 for connection data and Figure 3-1 for operating instructions.

Table 2-2. Lead Wire Selection Chart

SR-4 STRAINLINE
LEAD WIRE CODE & SELECTOR CHART

LEAD WIRE DESIGNATION CODE

ST C – 26 V – 3 RWB

TYPE

ST – Stranded
SD – Solid
RB – Ribbon

SIZE

American Wire Gage
No. or Ribbon Thickness
and Width in Thousandths
of Inch

NO. OF CONDUCTORS

1
2
3
4

COLOR

R – Red
W – White
B – Black
G – Green

MATERIAL

AU – Gold
C – Copper
NCC – Nickel Clad Copper
SSC – Stainless Steel Clad Copper
CON – Constantan
NIV – Nichrome V

INSULATION

V – Poly-Vinyl-Chloride
T – Teflon
SE – Solder-eze Varnish
F – Fiberglas
U – No Insulation

DESIGNATION	TEMP. RANGE	APPROX. OHMS/FT/COND	CATALOG NUMBER
STC-26V-1R, W, B, G, (Specify one color)		.04Ω/FT.	218909(B) 218911(R) 218912(G) 218910(W)
STC-26V-3RWB		.04Ω/FT.	218960
STC-26V-4RWBG	-100°F to +175°F	.04Ω/FT.	218961
STC-30V-3RWB		.1Ω/FT.	218962
STC-36V-4RWBG		.4Ω/FT.	218963
SDC-27SE-1	-150°F to +300°F	.05Ω/FT.	218964
SDC-34SE-1		.3Ω/FT.	218965
STC-26T-1R, W, B, G, (Specify one color)		.04Ω/FT.	218907(R) 218905(B) 218906(W) 218908(G)
STC-26T-3RWB	-450°F to +500°F	.04Ω/FT.	218967
SDC-36T-1R, W, B, G, (Specify one color)		.4Ω/FT.	218969(R) 218971(B) 218970(W) 218968(G)
RBCON 4x31U-1		2.4Ω/FT.	103153
RBNCC-2x12U-1		.3Ω/FT	216361
RBNCC-2x8U-1	to +900°F	.5Ω/FT.	216362
SDNCC-26F-1		.04Ω/FT.	218972
SDSSC-26F-1	to +1100°F	.04Ω/FT.	218974
SDNIV-26F-1		2.5Ω /FT.	218973
SDNIV-30U-1	to +1300°F	6.5Ω/FT.	218501
RBNIV-3x15U-1		14.5Ω/FT.	103152
MISCELLANEOUS			
22F (Fiberglas Sleeving)	1300°F		218502
24F (Fiberglass Sleeving)	2000°F		219012
SDAu-XU-1 (.003" Gold)	1600°F	33.5Ω/FT.	214128
CABLE			
Four Cond. shielded #20 AWG (Teflon insulated, neoprene jacket)	-40°F to 212°F		103998
Four cond. shielded #16 AWG (All Teflon insulation)	-20°F to 480°F		100110

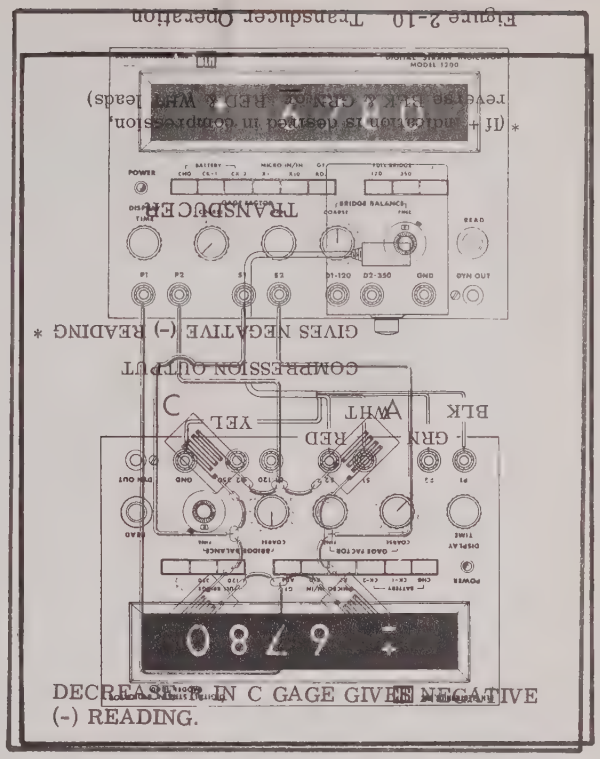


Figure 2-7. Four-Arm, Full Bridge Configuration

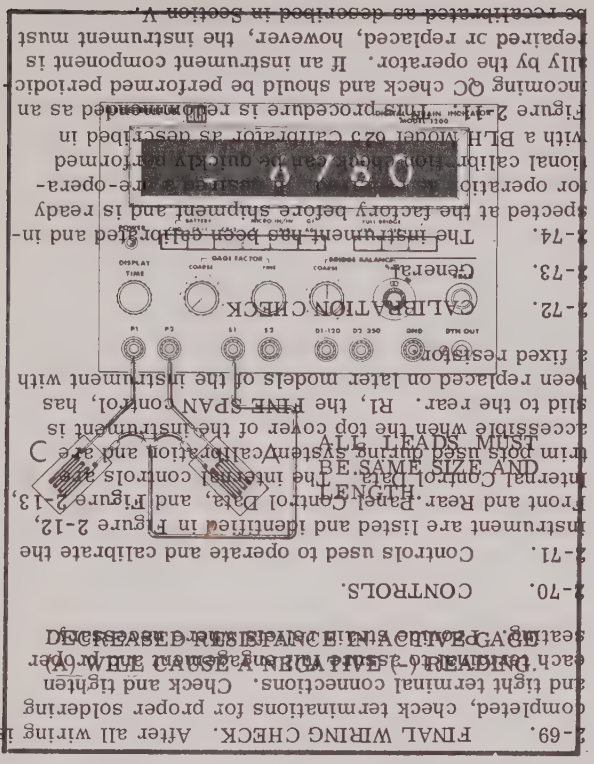


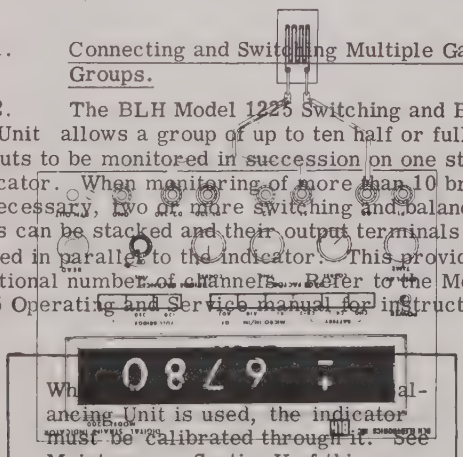
Figure 2-6. Typical Half Bridge Configuration

2-59. Quarter - Bridge.

2-60. Use of the self-compensated strain gage eliminates the need for a compensation gage in most cases. To avoid lead wire induced errors BLH recommends that the "three-wire" method of resistance measurement be used. See paragraph 2-48. Connect the gage to the instrument as shown in Figure 2-8 and 2-9. See Figure 3-1 for operating instructions.

2-61. Connecting and Switching Multiple Gage Groups.

2-62. The BLH Model 1225 Switching and Balancing Unit allows a group of up to ten half or full bridge outputs to be monitored in succession on one strain indicator. When monitoring of more than 10 bridges is necessary, two or more switching and balancing units can be stacked and their output terminals connected in parallel to the indicator. This provides an additional number of channels. Refer to the Model 1225 Operating and Service manual for instructions.



When the Model 1225 Switching and Balancing Unit is used, the indicator must be calibrated through it. See Maintenance, Section V of this manual, for complete instructions.

2-63. Semi-Conductor Gages.

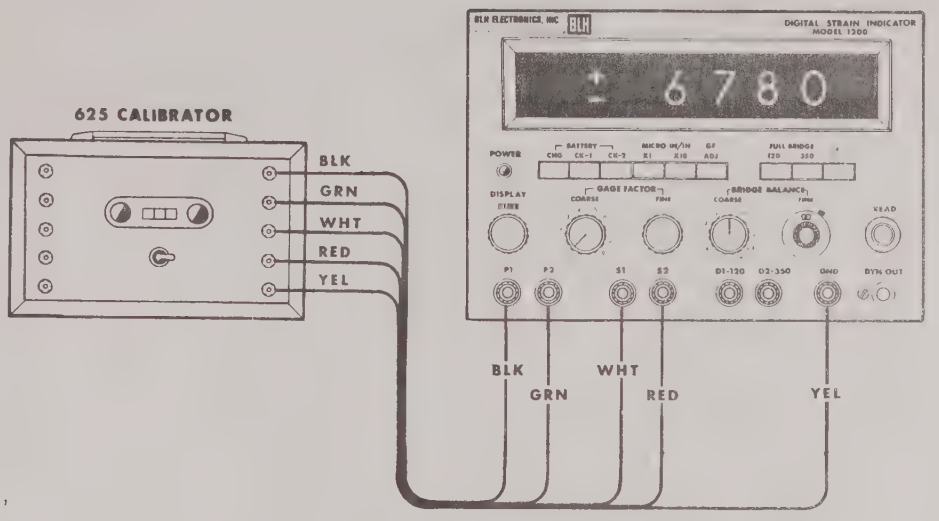
2-64. Semi-conductor strain gages cannot be used with the Model 1200. Instructions and a bill of materials for constructing an inexpensive but accurate semi-conductor measuring instrument are available from BLH at no cost.

2-65. Transducer Operation.

2-66. The Indicator can be used to measure the response of any BLH wire or foil strain gage load or pressure transducer. The bridge circuits of these cells are adjusted to a standard output and are all fully compensated for temperature. Connect the transducer to the terminals as shown in Figure 2-10. Refer to Section III of this manual for initial adjustments and detailed operating instructions.

2-67. Dynamic Strain.

2-68. Output is approximately ± 1.000V. for 10 000 microinches per inch. Maximum dynamic output is ±5V. It is not practical, however, to attempt dynamic strain readings with a DVM-type readout device. Dynamic strain should be monitored at the DYN OUT jack with an oscilloscope or recorder. The jack mates with H. H. Smith 3[illegible]09, 311 or 312. Connecti[illegible]



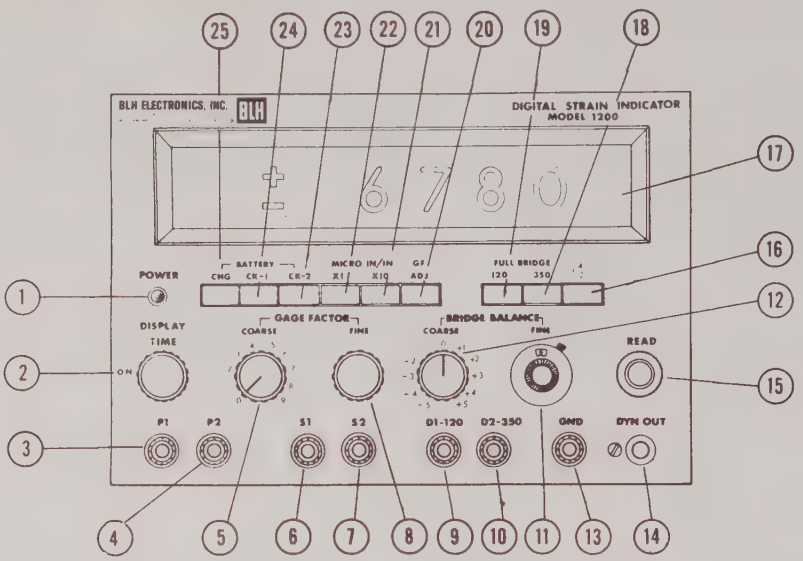
1. Connect Model 625 Calibrator to front panel of instrument as shown.
2. Press FULL BRIDGE 350Ω button on Model 1200. Place Model 625 bridge selector switch in the 350Ω position.
3. Turn DISPLAY TIME control clockwise until POWER indicator lights. For battery operated units, set to minimum time necessary to read display in order to conserve batteries (see paragraph 2-25).
4. Press GF ADJ button until display indicates 2.000.
5. Select X1 or X10 range. Adjust BRIDGE BALANCE controls for 0000 display.
6. Apply increments of 1000μin/in with Model 625 (see table). Linearity should be ±0.04% of reading ± 1 digit over each step. At each step, switch between the X1 and X10 ranges. Last digit in display should not vary more than ±4 counts at any point.

CONVERSION TABLE - MICROINCHES-PER-INCH TO MILLIVOLTS-PER-VOLT *

μ INCHES	Mv/V	μ INCHES	Mv/V	μ INCHES	Mv/V
0	0	1400	.70	4000	2.00
100	.05	1500	.75	4500	2.25
200	.10	1600	.80	5000	2.50
300	.15	1800	.90	5500	2.75
400	.20	2000	1.00	6000	3.00
500	.25	2200	1.10	6500	3.25
600	.30	2400	1.20	7000	3.50
700	.35	2500	1.25	7500	3.75
800	.40	2600	1.30	8000	4.00
900	.45	2800	1.40	8500	4.25
1000	.50	3000	1.50	9000	4.50
1200	.60	3500	1.75	9500	4.75
				10 000	5.00

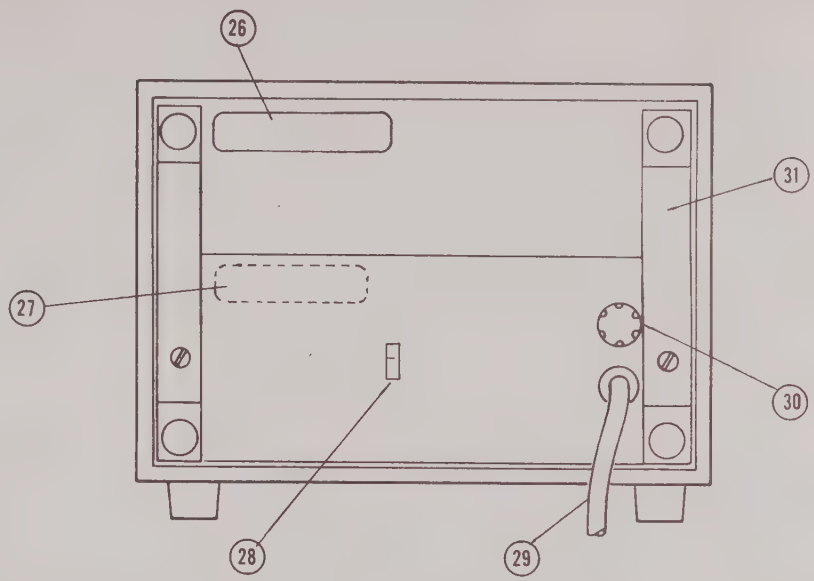
*(Simulates full, four-arm, active gage bridge; Gage Factor set to 2.000)

Figure 2-11. Calibration Check



1	POWER LIGHT	Light emitting diode. Glows when 4.8V bridge excitation voltage is being generated.
2	DISPLAY TIME	Applies line voltage to the instrument and bridge voltage to the gages. In battery operated instruments, all other power remains off until the PUSH-TO-READ button, (index #15) is pressed.
3	TERMINAL P1 (BLACK)	Bridge excitation terminal.
4	TERMINAL P2 (GREEN)	Bridge excitation terminal.
5	COARSE GAGE FACTOR	Used in conjunction with index #8 for setting approximate gage factor of gages in use.
6	TERMINAL S1 (WHITE)	- Signal input terminal
7	TERMINAL S2 (RED)	+ Signal input terminal. (full bridge only).
8	FINE GAGE FACTOR	Used in conjunction with index #5 for setting exact gage factor of gages in use.
9	TERMINAL D1, 120Ω (Blue)	120Ω quarter bridge + signal input terminal.
10	TERMINAL D2, 350Ω (Blue)	350Ω quarter bridge + signal input terminal.
11	BRIDGE ZERO FINE	Adjusts a no-load strain gage bridge output to indicate exactly zero.
12	BRIDGE ZERO COARSE	Adjusts a no-load strain gage bridge output to approximately zero.
13	TERMINAL GROUND (YELLOW)	Cable shield terminal (chassis is ground).
14	DYN OUT JACK	External connection point for measurement of dynamic (oscilliatory) signals with oscilloscope or recorder.
15	READ SWITCH	Battery saver circuit switch. When pressed, energizes the display which remains on for at least 15 seconds, maximum, depending on the setting of the display time control.
16	1/4, 1/2 BRIDGE SELECTOR SWITCH	Places proper bridge completion resistors in circuit when using 1/4 or 1/2 bridge configurations.

Figure 2-12. Front and Rear Panel Control Data



17	DIGITAL DISPLAY	Four 0.5" H miniature glow discharge tubes. Automatic with + and - polarity indicators. Also displays battery voltage and GF settings on command. Overrange digit "1" appears to the left of the MSD at measurements in excess of 9999 microinches per inch.
18	350Ω FULL BRIDGE SELECTOR SWITCH	Places proper bridge balancing network in circuit when 350Ω full bridges are used.
19	120Ω FULL BRIDGE SELECTOR SWITCH	Places proper bridge balancing network in circuit when 120Ω full bridges are used.
20	G. F. ADJ	Displays gage factor set into instrument with coarse and fine gage factor controls. Resolution is 0.001.
21	MICRO IN/IN X10	When pressed, indicator will measure strain to 100,000 microinches per inch. Figure displayed must be multiplied by 10 for actual strain. Resolution is ± 10 microinches per inch.
22	MICRO IN/IN X1	Displays actual strain up to 10000 μ"/" ±1μ"/" when pressed.
23	BATTERY CK2	When pressed, combined voltage level of the four 1.2 volt nickel cadmium batteries is displayed;-4.8V is nominal. Recharge below -4.1V (4100 in display).
24	BATTERY CK1	When pressed combined voltage level of the four 1.2V nickel cadmium logic supply batteries is displayed. +4.8V is nominal. Recharge below +4.1V (4100 in display).
25	BATTERY CHG	Activates battery charging circuit. Press whenever BATT CK1 and BATT CK2 display a reading below 4100. Strain readings cannot be taken when button is in.
26	NAMEPLATE	Signal conditioner nameplate and serial number.
27	NAMEPLATE	Power supply nameplate and serial number (located inside chassis).
28	115/230V SLIDE SWITCH	Selects either 115Vac or 230 Vac primary power input configuration.
29	POWER CORD	Three conductor power cord for primary line voltage input.
30	LINE FUSEHOLDER	Contains 0.3 ampere time-delay fuse.
31	BRACKET	Combination stand and power cord storage brackets.

Figure 2-12. Front and Rear Panel Control Data (Cont'd)

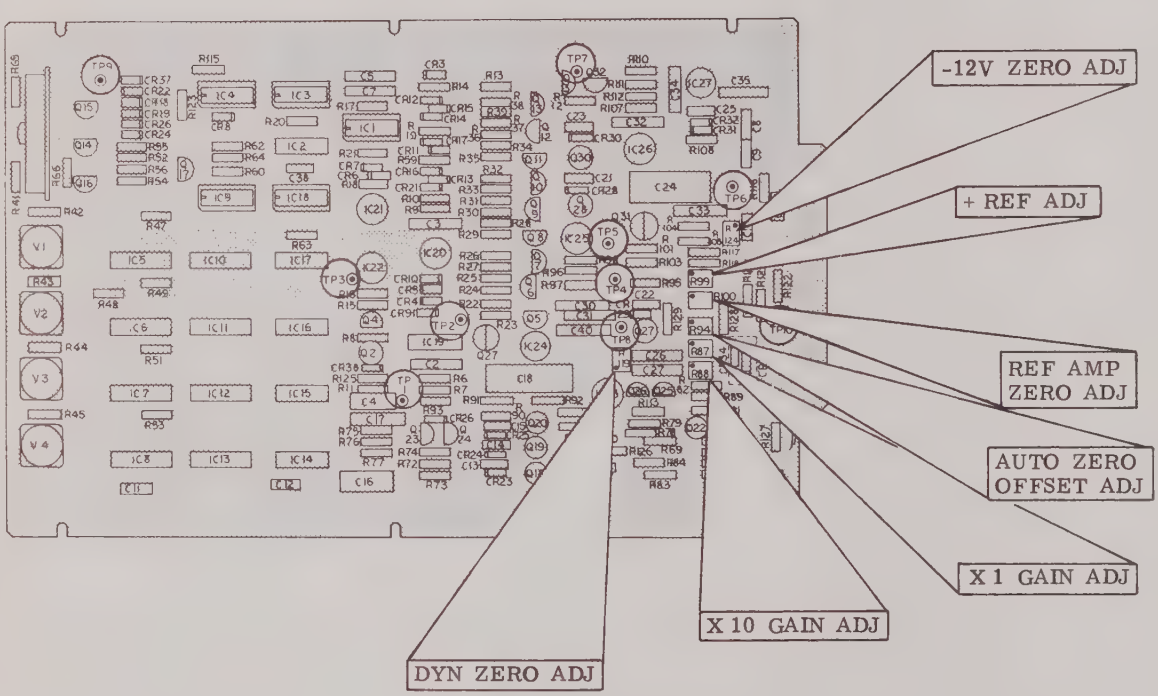


Figure 2-13. Internal Control Data

SECTION III
OPERATION

3-1. GENERAL.

3-2. Illustrations of the control panel are used to describe the sequential operation of the system. The circled numerals on the controls are keyed to the step, or steps, in which the control is used. If other readout devices are used to monitor load, the indicating instrument should be calibrated according to the manufacturer's instructions before operation.

3-3. OPERATION.

3-4. Half Bridge Operation.

3-5. When an active and compensating gage or two active gages are connected to the instrument in a two-arm half bridge, the 1/4 - 1/2 button must be pressed, regardless of the actual resistance of the gages in the half-bridge.

3-6. When the switch is placed in this position, two bridge completion resistors of the appropriate value are placed into adjacent arms of the gage circuit completing, internally, a Wheatstone bridge. Initial bridge unbalance is cancelled with the COARSE and FINE BRIDGE BALANCE controls.

3-7. Full Bridge Operation.

3-8. The Bridge Selector Switch maintains the full balancing range of the instrument at each of the full bridge (four arm) settings (120 and 350 ohms). If the initial unbalance of the gage bridge is greater than the zero range of the instrument at the 350 ohm setting, the zero range can be increased by pressing the 120 ohm button. The above procedure is valid

3-9. Transducer Operation.

3-10. The mV/V output of a BLH wire or foil strain gage transducer will be displayed in microinches per inch when the GAGE FACTOR controls are set for 2.000. This setting is the same for both 2mV/V and 3mV/V transducers.

3-11. At the above gage factor setting, the full scale output of a 2mV/V transducer will appear in the digital display as 4000 microinches per inch and a 3 mV/V transducer as 6000 microinches per inch (1mV/V = 2000 microinches per inch). Readout will be linear (i.e. at half of full scale load, a 2mV/V transducer output will be displayed as 2000 microinches per inch; at quarter of full scale load, 1000 microinches per inch, etc.).

3-12. It may be more desirable, however, to have the instrument indicate transducer output in engineering units (pounds, inches, units of flow, etc.). rather than in microinches per inch. A 2mV/V, 5000 pound capacity load cell, for example, will normally display a full scale readout of 4000 microinches per inch at the gage factor setting of 2.000 as stated in paragraph 3-11. If it is more convenient to have a full scale readout of 5000 counts (to coincide will the 5000 pound full scale output) proceed as follows:

a. Check calibration of the Model 1200 as described in Figure 2-11.

b. Press the GF ADJ button and adjust the GAGE FACTOR CONTROLS until the digital display indicates 2.000.

c. Press the MICRO IN/IN X1 button and apply load to the transducer until a full scale readout of 4000 microinches per inch is obtained. (A Model 625 Calibrator can be used to simulate a full scale reading in lieu of the actual transducer).

d. With the MICRO IN/IN X1 button still depressed, adjust the GAGE FACTOR controls until the digital display indicates 5000 counts.

Every count in the digital display will now be equivalent to 1 pound of applied force on the transducer. Readout will remain linear; at half scale, display will indicate 2500, at quarter scale, 1250, etc.

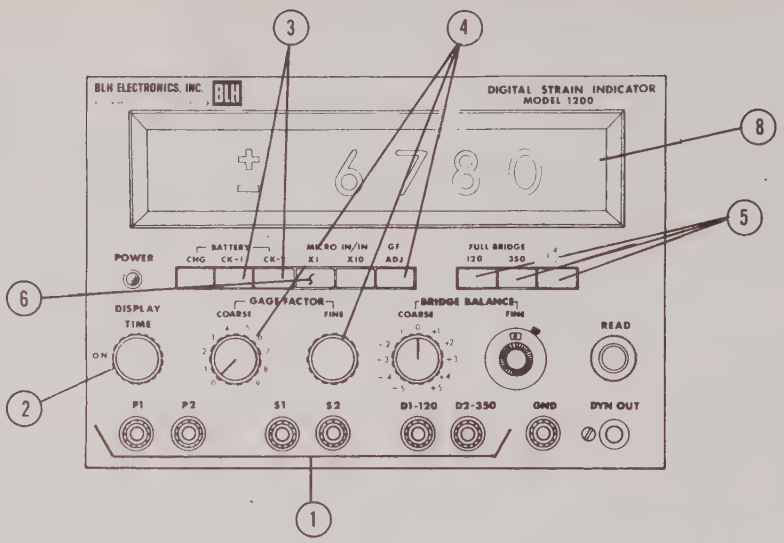
3-13. The procedure is similar for transducers with full scale outputs other than 2 mV/V. A 3mV/V full scale output transducer, for example, is first loaded to indicate 6000 microinches per inch at a gage factor setting of 2.000. The GAGE FACTOR controls are then adjusted for the desired readout in engineering units.

NOTE

DECREASING the GAGE FACTOR setting INCREASES the readout indication; INCREASING THE GAGE FACTOR setting DECREASES the readout indication without loss of linearity within the specified gage factor range.

3-14. Initial Calibration Check.

3-15. An initial calibration check to verify adjustment can be performed prior to placing the system in operation. Figure 2-11 illustrates procedure. Further calibration data is provided in Section V of this manual.



(1) Select quarter, half bridge or full bridge configuration desired and connect gages to binding posts of indicator as described in Section II of this manual.

(2) Turn DISPLAY TIME control clockwise until POWER indicator lights. For battery operated units, set to minimum time necessary to read display in order to conserve batteries (see paragraph 2-25).

(3) For battery operated units, press BATTERY CK-1 and CK-2 switches. Display should indicate 4100 or better. If not, plug in instrument and press CHG button.

IMPORTANT

Battery operated instruments will not indicate until READ switch is pressed. When read switch is pressed, reading will appear in digital display for at least 15 seconds, maximum, depending upon the DISPLAY TIME setting.

(4) Press GF ADJ button and adjust GAGE FACTOR controls until gage factor of gages in use (marked on package) appears in digital display.

(5) Press BRIDGE SELECTOR button for configuration in use, 120Ω, 350Ω or 1/4-1/2 bridge (disregard resistance for 1/4 and 1/2 bridges).

(6) Select X1 or X10 scale with micro in./in. switch. Cancel initial bridge unbalance with COARSE and FINE BRIDGE ZERO controls.

(7) Load gages or transducer.

(8) Read display.

Figure 3-1. Instrument Operation

SECTION IV
PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. The Model 1200 Strain Gage Signal Conditioner is designed to amplify and display in microinches per inch, a change in voltage caused by resistance changes in wire and foil strain gages. A plug-in power supply produces a precise -4.8V regulated strain gage excitation voltage at front panel terminals P1 and P2.

4-3. General Operation.

4-4. The quarter, half, or full strain gage bridge is initially balanced in an unloaded or unstrained condition (with excitation applied) by adjusting the COARSE and FINE BRIDGE BALANCE controls. When the gages are subjected to strain, the bridge becomes electrically unbalanced and produces a signal at terminals S1 and S2 (full bridge) or at terminals S2-P1 (120Ω quarter bridge) or at terminals S2 - P2 (350Ω quarter bridge). Refer to the instrument Block Diagram, Figure 4-1 and the Functional Diagram, Figure 4-2.

4-5. When the bridge selector switch is in the 1/4-1/2 position for quarter or half bridge operation, two 500Ω bridge completion resistors are placed into the measuring circuit as shown. In the 1/2 bridge mode of operation, signal input to the preamplifier is at terminal S2. In the 1/4 bridge position an additional bridge completion resistor is placed into the circuit when terminal D1 (120Ω) or terminal D2 (350Ω) is jumpered to S2.

4-6. In the full bridge, or transducer mode of operation, the bridge selector switch is set to the 120 or 350 ohm position, dropping the two 500Ω bridge completion resistors and placing a fixed bridge balance resistor of the appropriate value in the bridge balance circuit. Exact balance is reached with the COARSE and FINE BRIDGE BALANCE controls. Signal output is at terminals S1 and S2. Strain gage excitation voltage is applied to the bridge at the black (P1) and green (P2) terminals in the 1/4-1/2 and full bridge modes of operation.

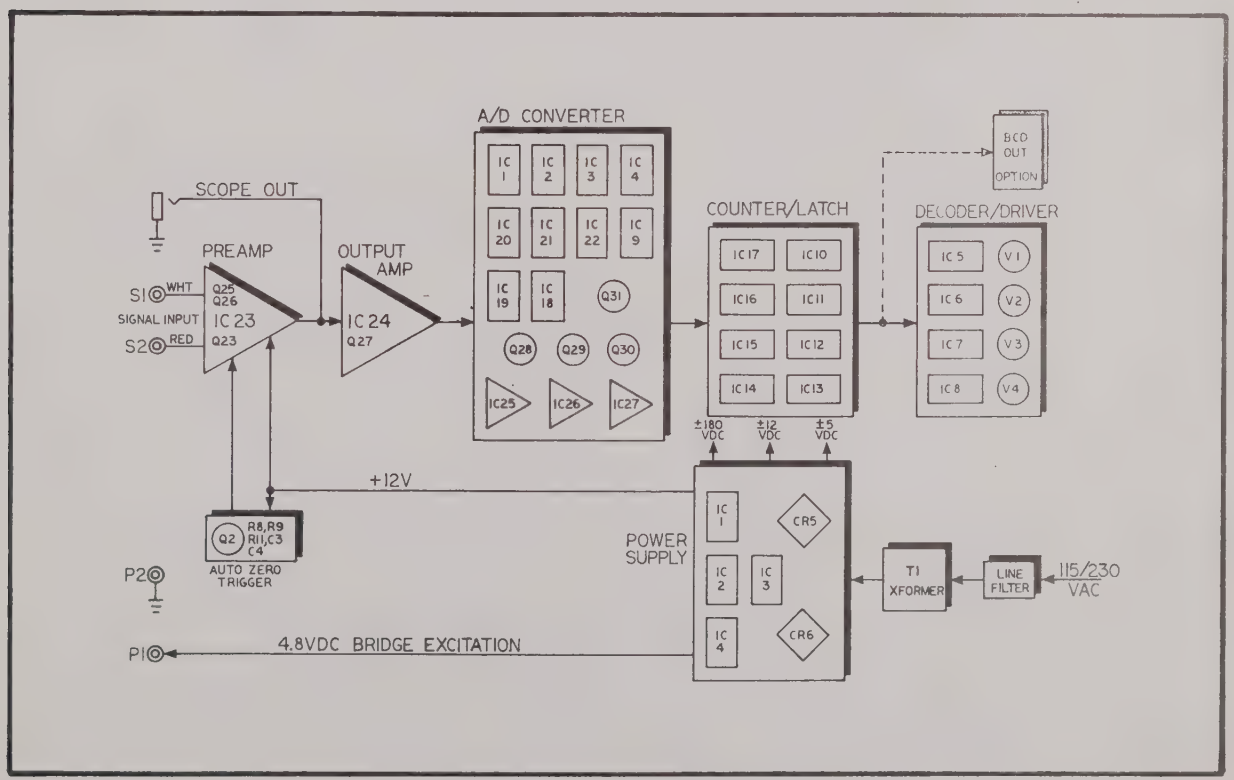


Figure 4-1. Block Diagram

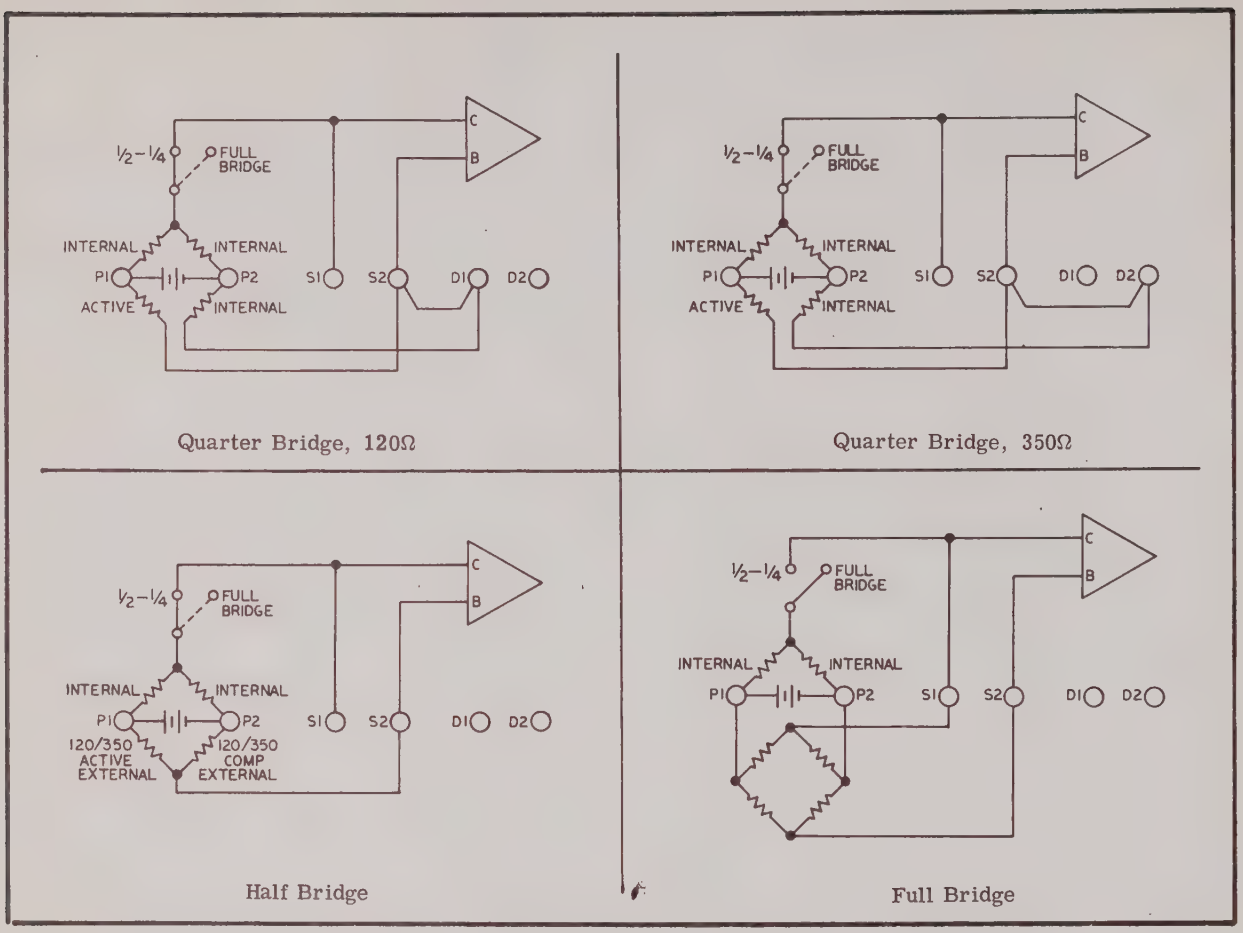


Figure 4-2. Fuctional Diagrams, Gage Circuits

4-7. Preamplifier.

4-8. The preamplifier conditions the input signal from the strain gage bridge for presentation to the A to D converter. An integral part of the amplifier is the auto zero circuit which senses and eliminates drift induced offset voltages in the circuit between sample times (2 per second).

4-9. Operation of the preamplification circuit is largely dependent upon the timed operating and closing of FET (field effect transistor) switches along the signal path. When the measurement cycle starts, FETS Q18 and Q20 close, allowing signal at pins P2B and P2P to pass through the first amplifier stages to the FET buffer amplifier. The buffer amplifier is a multiple stage differential amplifier. The first stage is a dual FET (Q27) and the second stage the operational amplifier, IC 24. The circuit is equivalent to a high impedance emitter follower and is utilized to minimize signal losses. Q18 and Q20 are opened and closed by the sampling rate multivibrator Q23 and Q24 twice a second. The outputs of emitter followers Q25 and Q26 are fed to the operational amplifier IC23.

4-10 Q22 is a constant current source for Q25 and Q26 referenced to Zener CR27. The output from IC23 is coupled through C18 to the buffer amplifier Q27. Buffer amplifier Q27 is a differential amplifier with the input signal at the other gate. The outputs from Q11 drive the integrated circuit IC24. The combination of Q11/IC24 is equivalent to an emitter-follower but with much higher impedance to minimize signal losses.

4-11. Auto Zero Circuit.

4-12. The automatic zero function is controlled by the monostable multivibrator Q23 and Q24. The multivibrator delivers a ± 15 volt potential to the gates of the JFETS twice a second when activated by the auto zero triggering circuit. The pulse is coupled into the multivibrator at pin P24. When a negative voltage is applied to the gate of Q18, Q18 opens interrupting the input signal. Simultaneously Q19, closes, shorting the inputs to Q25 and Q26. Q20, closes tieing C18 to ground; C7 is allowed to charge to the level of any existing offset voltage present in the amplifier.

4-13. At the beginning of the next sample time, when the control multivibrator reverses the state of the JFETS, the stored offset voltage eliminates (bucks out) the offset portion of the signal

4-14. Sample Rate Oscillator.

4-15. The Sample Rate Oscillator circuit, Figure 4-3 is a relaxation oscillator pulse generator. At the beginning of each cycle, the emitter of Q2 is reversed biased to a nonconducting state. As capacitor C4 is charged through resistor R9, the emitter voltage rises exponentially towards the +12V supply voltage. When the emitter voltage reaches a peak point level, the emitter becomes forward biased and the dynamic resistance between the emitter and base-one drops to a low value. Capacitor C4 then discharges through the emitter until the emitter ceases to conduct, and the cycle is repeated.

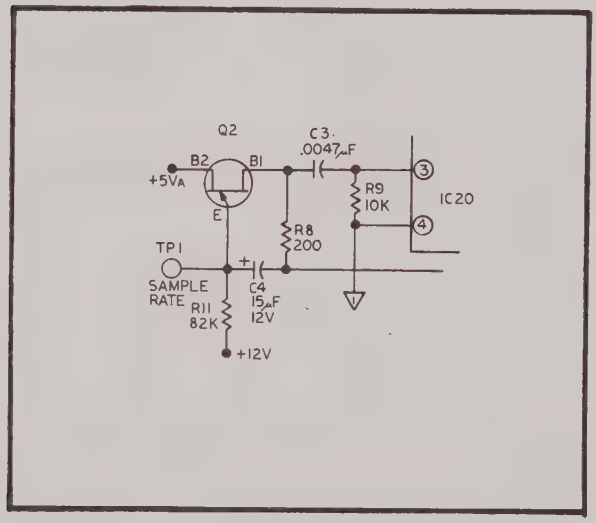


Figure 4-3. Sample Rate Oscillator

4-16. Each time Q2 conducts, a current pulse flows in the emitter, base-one and base-two circuits. The discharge current of C4 generates a low output impedance pulse. This pulse controls the opening and closing of the auto zero circuit FET switches in the preamplifier. Triggering rate is determined by the value of R9.

4-17. Analog to Digital Converter.

4-18. The A to D Converter is an integrating voltage to proportional count device that produces an output pulse train. The number of pulses (counts) contained in the output train is an exact function of the unknown input signal voltage. The count output is gated to the input of the counter and latch circuit, the output of which is a parallel digital code. In addition to the count output, the converter also provides a reset command to the counter and latch and accepts a full scale count carry signal from the counter.

4-19. Basically, the conversion technique is a sampling function coupled with dual slope integration; a two step process. In the first step, the unknown input from the preamplifier is fed through an operational amplifier to an integrating capacitor. The output of this integrator is an increasing voltage with a slope proportional to the input.

4-20. Integration time is controlled by counting 10 000 counts from a clock oscillator. In the second step, the integrator output is driven back to zero. The shape of the decreasing voltage is constant, therefore the time is proportional to the unknown input. This time is measured by counting pulses from a clock oscillator. The count is converted to BCD in the counter and latch circuit, stored, and finally displayed as a decimal digital readout.

4-21. The same integrating component and clock oscillator are used in both steps. Any shift in component values caused by temperature drift or aging is self-cancelling. The second step is a direct comparison to the internal reference voltage insuring long term stability.

4-22. During the up or signal integrating time period, the output of the auto-zeroed preamplifier is integrated by the integrating amplifier R102, Q31, IC26, and C24. During down integration, R102 is replaced with R101 and the unit down integrates using the +5V or -5V reference at pins 19 or 21. The choice of the + or - reference is determined by the polarity of the preamplifier output. The -5V at pin 19 is the same excitation voltage used to excite the strain gage bridge. The +5V reference is obtained by inverting this voltage with an inverting amplifier IC 25 and its associated circuitry. The measurement is ratiometric and for first order approximation is independent of variations in the -5V supply.

4-22. Gage Factor Adjustment.

4-23. When switch S1 is closed, the electrical positions of R101 and R102 are essentially reversed. The -5V is connected through R101 to the integrator on the up integration period and the +5V reference through R102 during down integration.

4-24. Refer to the Simplified Schematic, Figure 4-4. In the GAGE FACTOR ADJ mode, the circuit up integrates the -5V reference through S1 and R101 and down integrates the +5V reference through S2 and R102. Up integration time is 10 000 counts; if R102 equals R101, the down integration time is also 10 000 counts (gage factor setting). If R102 were zero, the down integration time would be 0000 for a gage factor setting of 0000.

4-25. In the normal mode, the output of the integrator during the up integrating period is directly proportional to the gage factor of the strain gage and inversely proportional to R102, the gage factor network.

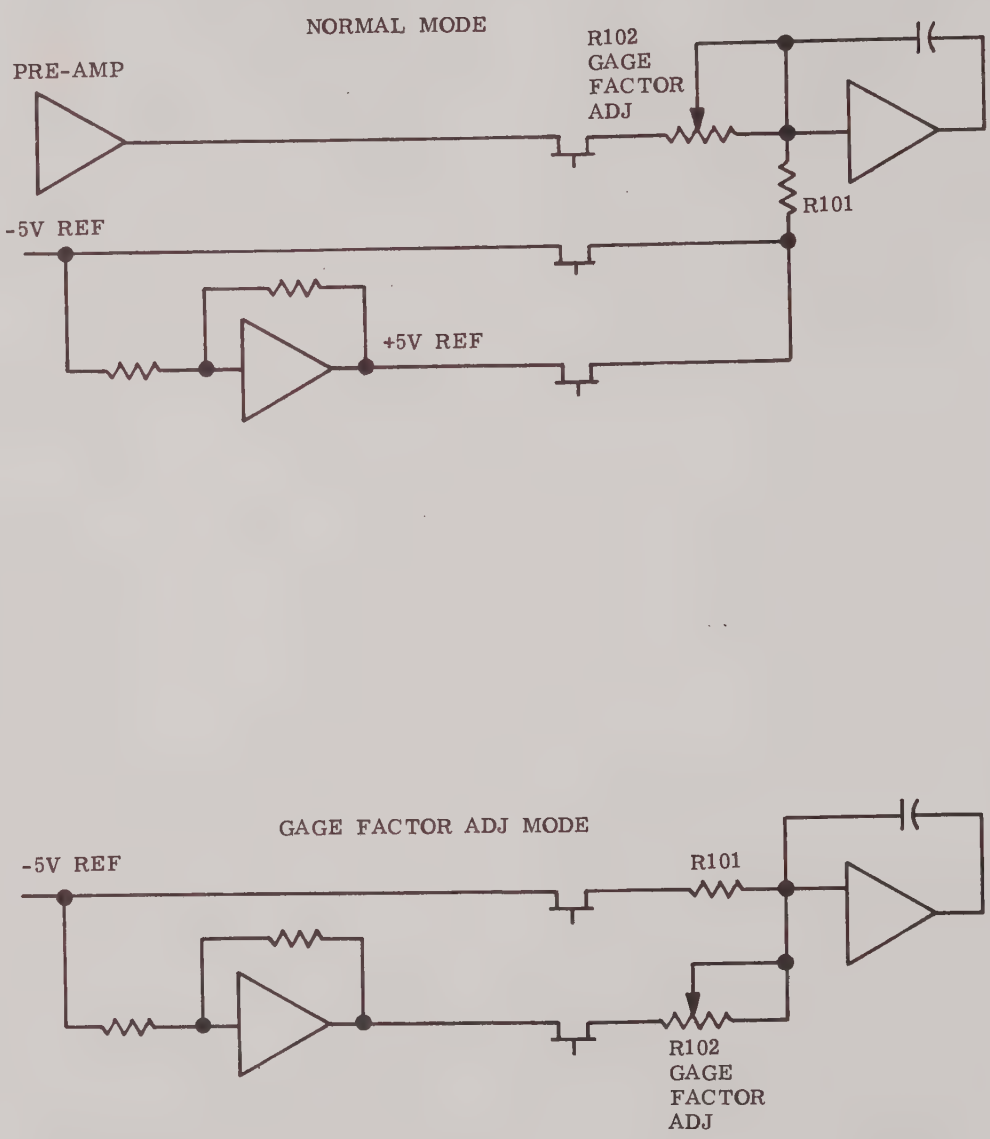


Figure 4-4. Simplified Schematic, Gage Factor Circuit

4-26. Counter and Latch.

4-27. The counter and latch circuit, is composed of four identical decades. Each decade is made up of an 8-4-2-1 BCD counter and a gated latch storage unit. The counter accepts pulses from the converter and divides the frequency by 10. Output from the 8 bit is fed to the next decade; all four bits are fed to the storage unit. At the end of encoding, the four bits in the counter are transferred into the flip-flops in the storage unit which ignore any changes in the state of the counter until the next end of conversion pulse.

4-28. Digital Display.

4-29. Latch unit outputs are converted to the inputs of the decoder drivers in the display circuit. The decoder drivers contain internal logic which converts the binary input into one-out-of-ten information. Output is in the form of ten high-voltage driver lines which are connected to the ten cathodes of the side reading digital display tubes, (V1, V2 etc).

4-30. POWER CIRCUIT ANALYSIS.

4-31. General.

4-32. The Model 1200 Power Supply consists of either an 115V ac ± 10%,50 to 400Hz (230 Vac optional) plug-in power supply unit or a plug-in rechargeable battery pack.

4-33. AC SUPPLY. Either 115V or 230V ac power is connected through fuse F1 (0.3 amp Slo-blo) and the line filter which is composed of chokes L1 and L2 and capacitor C13 to the primary of power transformer T1. Voltage selector switch S1 selects primary windings for 115V or 230V ac operation.

4-34. Voltage developed on the secondary windings is applied to two full bridge rectifiers CR5 at pins 5 and 6 and CR6 at pins 7, 8 and to half wave rectifier CR1 at pins 10, 11,and 12. CR5 produces ± 180V, unregulated, at pins E/5, H/7 and Y/21 of connector P1.

4-35. Rectified voltage at CR6 is regulated at IC1, a positive voltage regulator used with an external pass transistor. This increases output capacity at IC1 and makes available +12V ±5% at pins J/8 of connector J1. Rectified voltage at CR6 is also applied to the precision voltage regulators, IC's 2 and 3. IC's 2 and 3 are wired as negative voltage regulators and produce a regulated -12V, and -5V, respectively, at pins U/17 and W/19, K/9 of connector J1.

4-36. Voltage developed at pins 10, 11, and 12 of the secondary windings of T1 is applied to a half wave rectifier, CR1. The rectified voltage is regulated at IC1, a positive voltage regulator also used with an external pass transistor for external current output capacity.

4-37. BATTERY PACK. The rechargeable battery pack completely interchangeable with the ac power supply without modification. The pack consists of eight 1.2V rechargeable nickel cadmium batteries. The batteries are rechargeable from either a 115V or 230V ac power source. Four batteries form a +4.8V supply for the digital logic supply and four form a -4.8V supply for strain gage bridge power. A dc to dc converter operating from the ± 4.8V supplies produces +180V for the digital display and a ±12V supply for analog circuits.

4-38. The battery saver circuit increases the working life of the batteries, which are rated for one hour continuous duty. When the READ switch is closed, capacitor C4 is charged to +4.5 volts and transistor Q1 conducts. This energizes the relay, K1, which switches on the instrument. The length of time the instrument stays on is a function of value of C4 and the resistance setting of the DISPLAY TIME potentiometer.

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. General.

5-3. This section provides the information and outlines the procedures necessary for the proper maintenance and service of the Model 1200 Digital Strain Indicator.

5-4. Information includes preventive maintenance (paragraphs 5-11 through 5-21), troubleshooting (paragraphs 5-22 through 5-39), repair and replacement (paragraphs 5-40 through 5-60), and calibration (paragraphs 5-61 through 5-67).

5-5. Test equipment recommended for checking and troubleshooting the instrument is listed in Table 5-1. Test instruments other than those listed can be used providing the performance equals or exceeds the required specifications.

5-6. Cover Removal.

5-7. The front cover of the indicator is easily removed by lifting the latches located on the sides of the case as shown in Figure 5-1. A simplified instruction card showing typical gage hookups and instrument operation is mounted inside the cover.

Table 5-1. Recommended Test Equipment

TYPE	CHARACTERISTICS	USE	RECOMMENDED
Calibrator	Output accuracy at each point 0.1% or ±0.0003mV/V whichever is greater.	Troubleshooting, Calibration	BLH Model 625 Precision Calibrator
AC/DC VTVM	1mV to 100V, 10 megohm impedance.	Troubleshooting, Adjustment	
Decade Resistor	Total resistance, 10,000 ohms multiple of 1 ohm 0.05% accuracy.	Troubleshooting	
Multimeter	1% accuracy at full scale input impedance 100 megohms	Troubleshooting	Hewlett Packard Model 414A
Oscilloscope	200kHz bandwidth	Calibration, Troubleshooting	
Variable Power Transformer	0-230Vac	Troubleshooting	VARIAC
Standard Dead Weights	Class C or better - capacity to suit system.	Calibration	

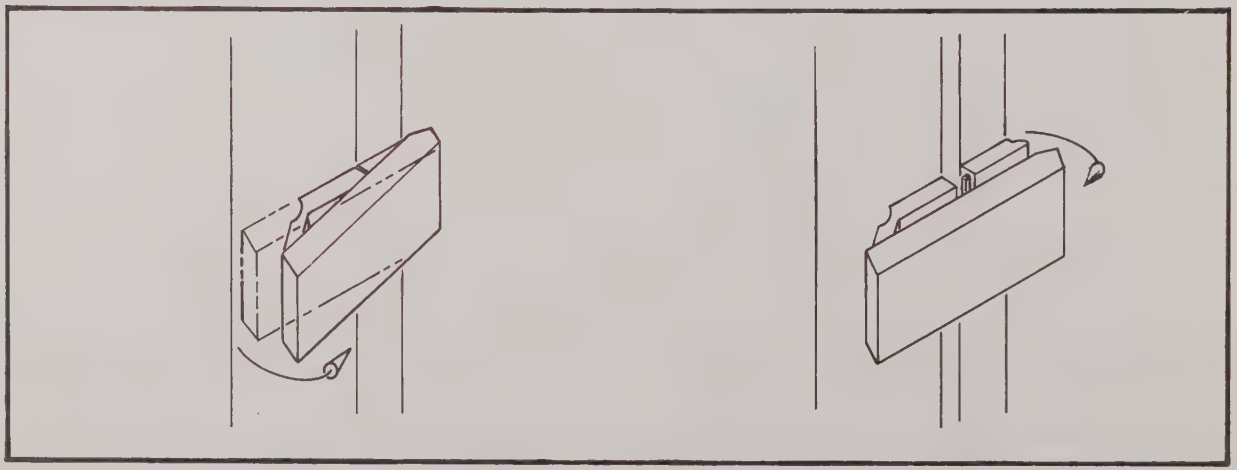


Figure 5-1. Cover Removal

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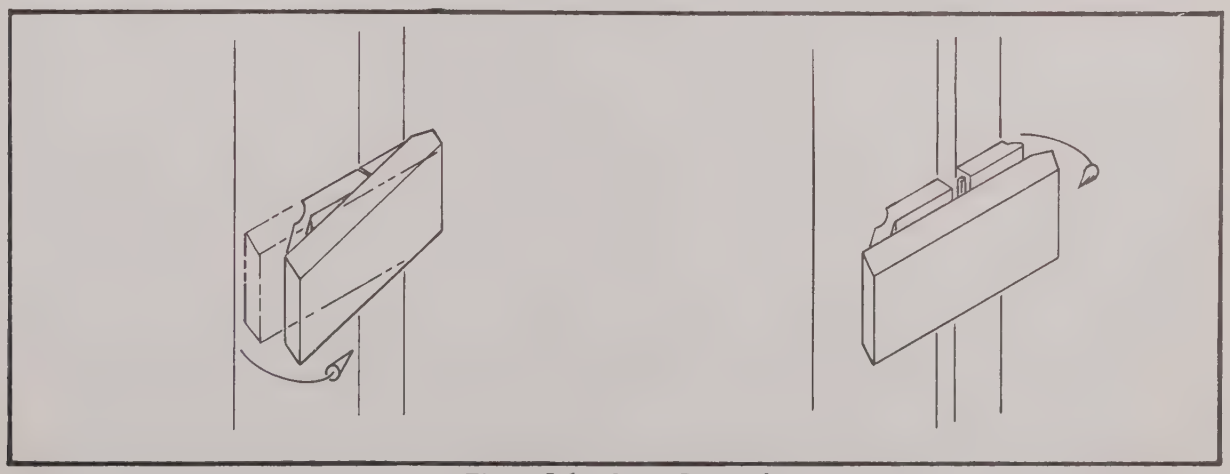


Figure 5-1. Cover Removal

5-8. The chassis must be removed from the case for the replacement or installation of printed circuit boards and individual components (Figure 5-3) and for access to the test points and adjustable controls, (Figure 5-4).

5-9. Refer to Figure 5-2 and remove the chassis as follows:

a. Unplug instrument and unlatch and remove front cover (see paragraph 5-6).

b. Locate and remove the two 6-32 x 3/8 rear panel power supply retaining screws.

c. Locate and remove four phillips-head front panel retaining screws.

d. Withdraw power supply by pulling it directly to the rear as shown. If power supply does not move easily, rock it gently from side to side while pulling rearward. (See Figure 5-5 and 5-6 for location of Power Supply components.)

e. When the power supply is removed, four chassis retaining screws are exposed. Remove.

f. Grasp front panel of indicator and withdraw chassis directly to the front as shown.

5-10. To check test points and make adjustments, place the front panel/chassis assembly on an insulated surface and plug in the power supply through an extender board. (See Inset, Figure 5-2.)

5-11. PREVENTIVE MAINTENANCE.

5-12. Cleaning.

5-13. The Indicator is enclosed in a vinyl-coated aluminum cabinet and should be cleaned only with a damp cloth moistened in a solution of warm water and mild detergent. Do not use any chemical solvents or abrasive cleaners on the vinyl case or anodized aluminum surfaces. Use a soft brush to remove external dust accumulation.

5-14. Loose dust within the chassis can be removed with dry, low-pressure, compressed air or a small vacuum cleaner. Contamination of the switches, circuit boards, or edge connectors will cause high impedance leakage paths and subsequent deterioration of instrument performance. Avoid touching any of these circuits with the bare fingers, as skin oils are extremely contaminating.

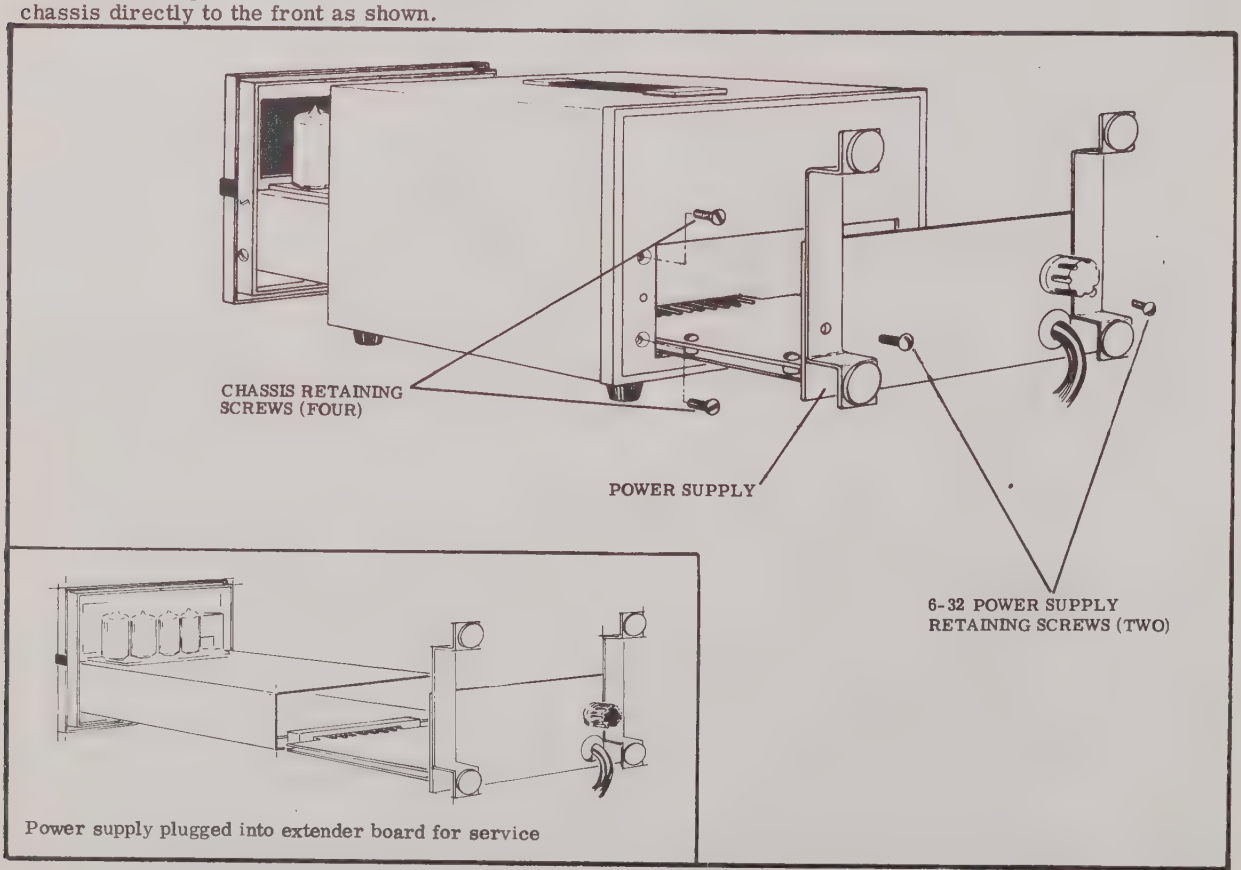

CHASSIS RETAINING SCREWS (FOUR)
POWER SUPPLY
6-32 POWER SUPPLY RETAINING SCREWS (TWO)
Power supply plugged into extender board for service

Figure 5-2. Chassis Removal

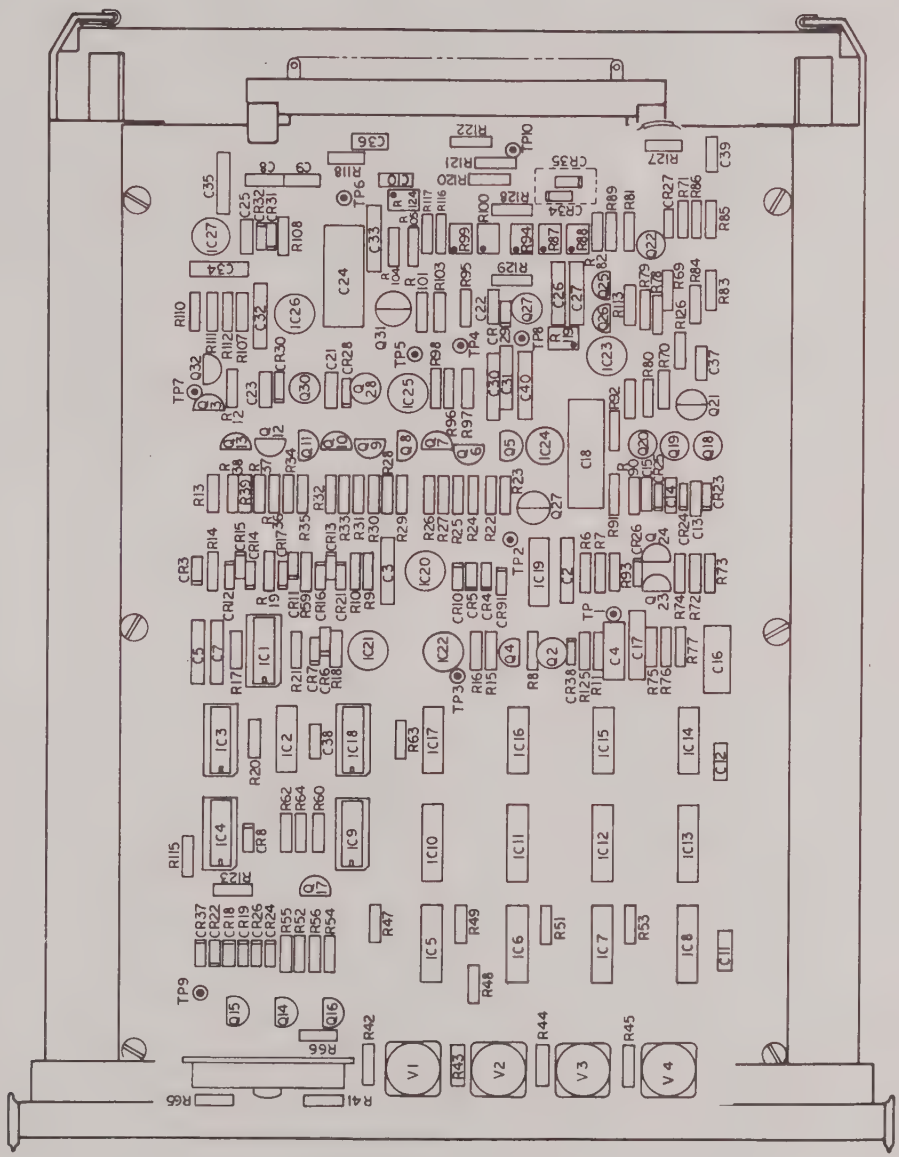
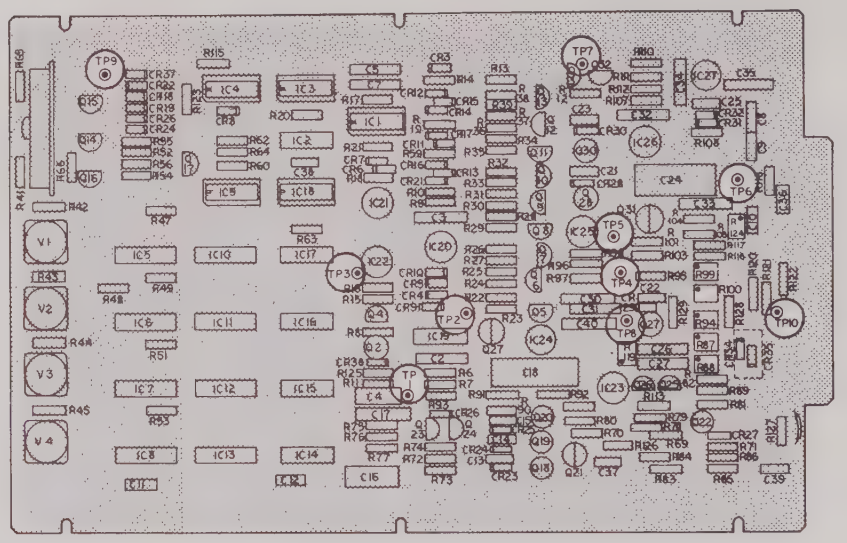


Figure 5-3. Component Location



TEST POINT	FUNCTION
TP1	SAMPLE RATE
TP2	CLOCK OUT
TP3	FULL SCALE COUNT
TP4	NEGATIVE REFERENCE
TP5	POSITIVE REFERENCE
TP6	INTEGRATOR OUT
TP7	COMPARATOR OUT
TP8	COMMON
TP9	INHIBIT PULSE
TP10	AUTO ZERO RETURN

Figure 5-4. Test Point Location

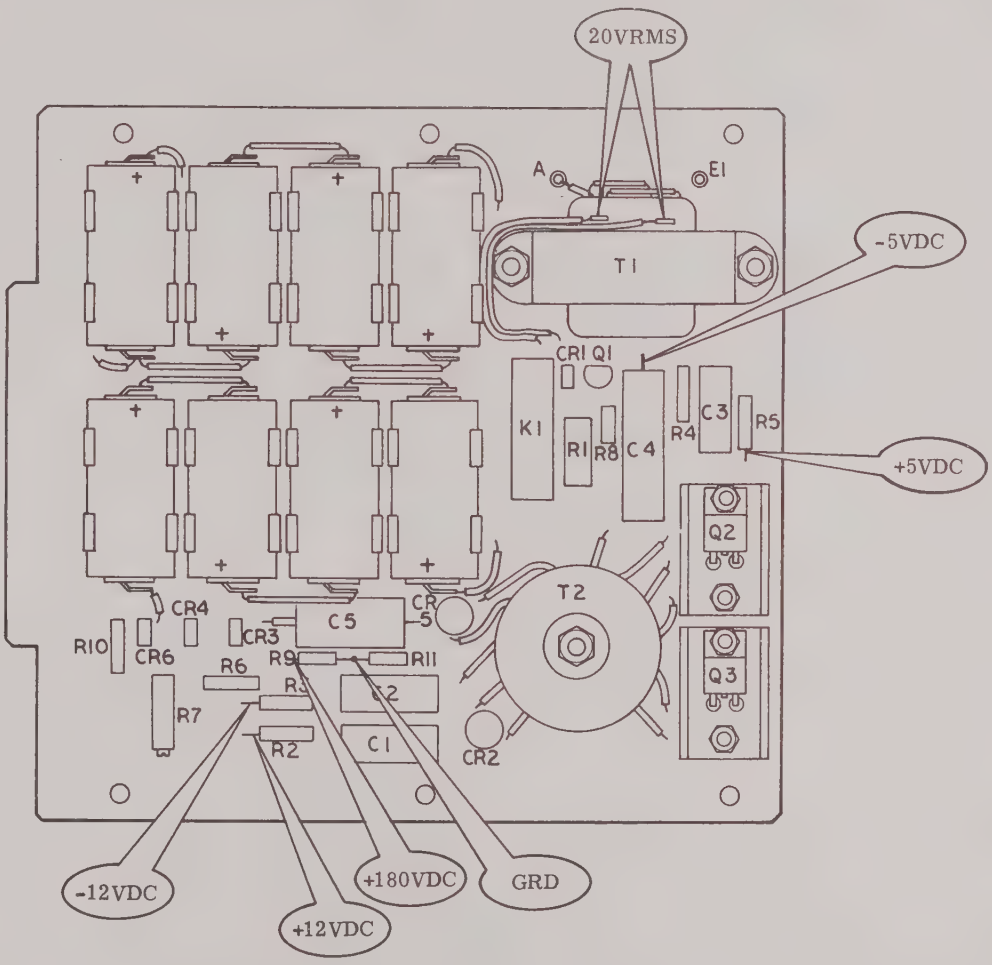


Figure 5-5. DC Power Supply Component Location and Voltage Levels

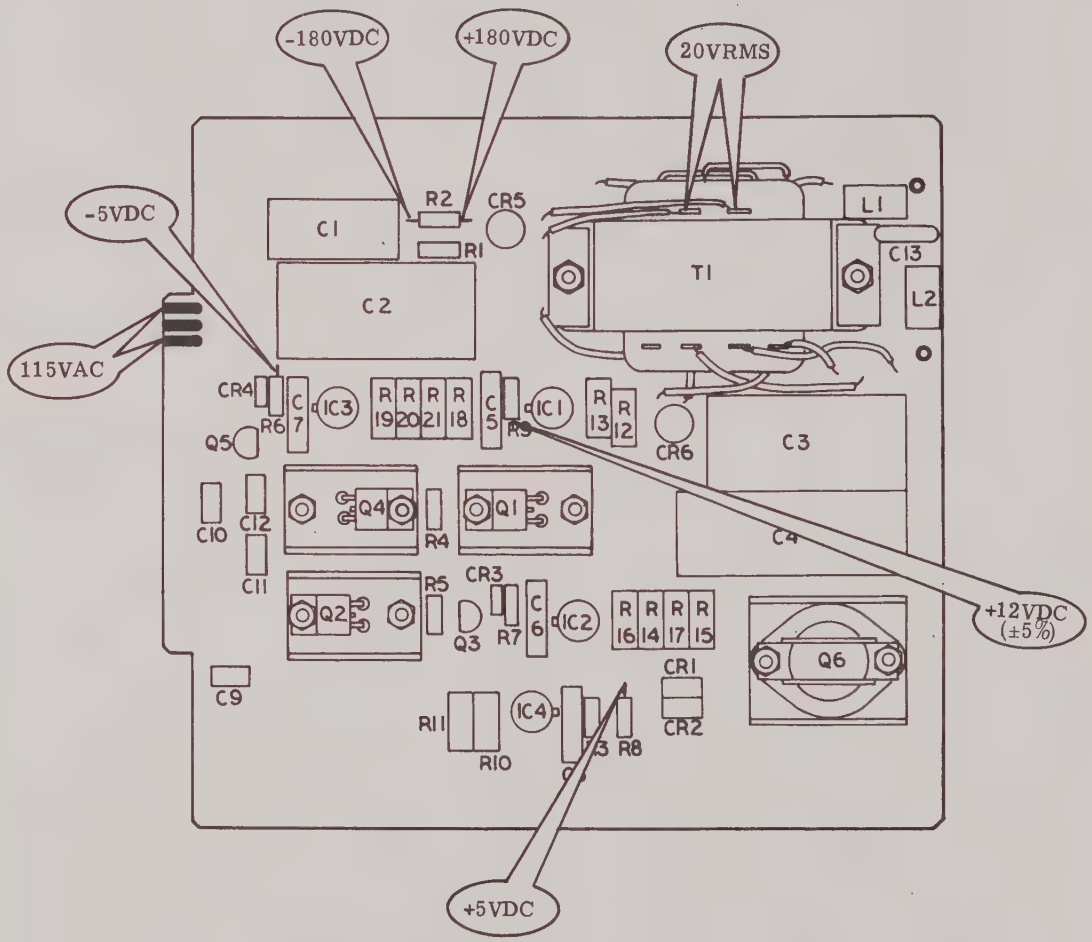


Figure 5-6. AC Power Supply Component Location and Voltage Levels

5-15. Do not use a pencil to trace circuits in the instrument. Graphite pencil lead is an excellent conductor and an accidentally introduced path of this type is often difficult to locate. If printed circuits do become contaminated during troubleshooting or replacement, clean with a weak solution of warm water and mild detergent. Rinse thoroughly with clean water and allow to dry completely before operating. Do not use alcohol or any other cleaning solution except detergent and water. PC board edge connections can be cleaned with a fiberglass brush , if available, or with an ordinary pencil eraser as indicated in Figure 5-7.

CAUTION

DO NOT USE COMMERCIAL MOISTURE SEALING SPRAYS ON THE BOARDS. APPLICATION OF THESE AGENTS WILL CAUSE LEAKAGE PATHS AND SUBSEQUENT DETERIORATION OF INSTRUMENT PERFORMANCE.

5-16. Lubrication.

5-17. Each pushbutton module has been lubricated during assembly and does not require further lubrication during normal operation. During continuous operation in extremely dusty environments, however, an occasional application of a commercial spray cleaner such as Miller-Stephenson MS-230 Contact RE-NU to both the pushbutton and rotary switches will clear the contacts of possible contamination. When lubricating the pushbutton switches, apply the cleaner / lubricator through an extension nozzle at the rear of the switch stator block as shown in Figure 5-8.

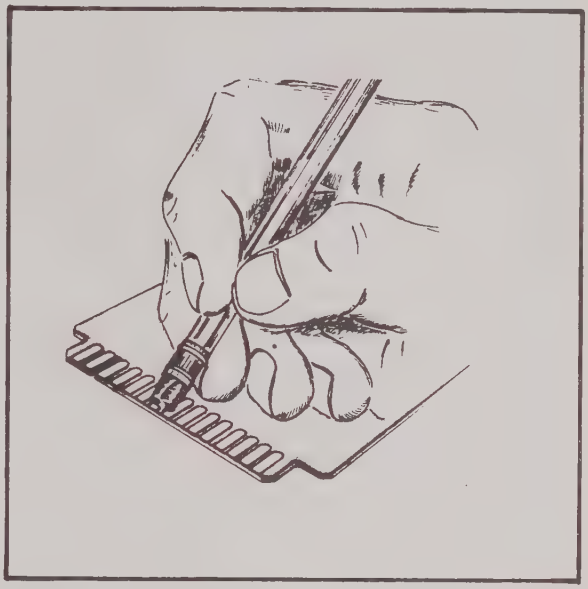


Figure 5-7. Cleaning PC Board Edge Connectors

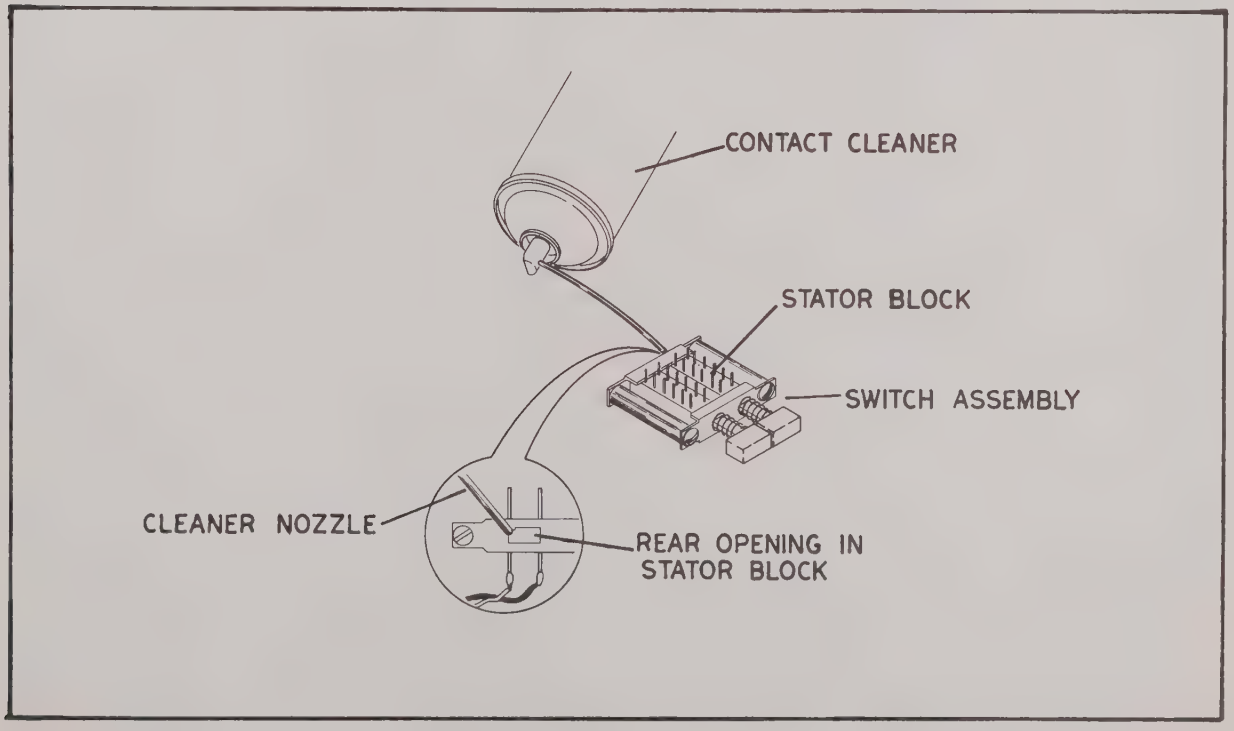


Figure 5-8. Switch Lubrication

5-18. Periodic Check.

5-19. BLH recommends that the instrument be performance tested on a quarterly basis (500 hours) if possible. During extended tests, where 24 hour operation is common, performance test the instrument during scheduled maintenance/cleaning downtimes or whenever possible. The calibration check in Section II provides a valid check of instrument performance that can be performed without disrupting normal test system operation.

5-20. The instrument can be returned to BLH for a thorough overhaul whenever necessary and checked with test instruments traceable to the National Bureau of Standards. If user maintenance and calibration is not feasible, or if unusual problems or applications are encountered, a visit by a BLH Field Service Engineer can be arranged through any of the Sales/Serivce Offices listed at the rear of the manual.

5-21. FACTORY SERVICE. If factory service is required, the instrument must be accompanied by the RETURN AUTHORIZATION FORM 862. Upon examination of the instrument at the factory, a full report on the instrument condition along with a quotation on repair cost (if not under warranty) and delivery time will be submitted to the customer before work is begun.

5-22. TROUBLESHOOTING.

5-23. Preliminary.

5-24. The troubleshooting techniques discussing the following paragraphs apply to both the AC and BAT operated instruments. The basic tools for troubleshooting are the schematic diagram at the rear of the manual, the theory information in Section IV, and the Troubleshooting Aid, Table 5-2, in this section. The most effective method of troubleshooting is to sectionalize the malfunction to a specific unit before attempting to localize the problem to a particular circuit or stage.

5-25. Table 5-2 contains a summary of front panel symptoms that usually indicate the malfunction of a specific component or board; check before continuing troubleshooting process. Test point location and voltage limits at each point are illustrated and listed in Figure 3-5 and 5-6. Use of the extender board, P/N 417298-2, as shown in Figure 5-2, facilitates pc board-mounted circuits in the power supplies.

CAUTION

WHEN INSPECTING BOARDS DO NOT TOUCH EDGE CONNECTORS OR THE ETCHED CIRCUIT TRACE. DO NOT TRACE SIGNAL PATHS OR TEST COMPONENTS FOR LOOSENESS WITH A PENCIL AS IT IS POSSIBLE TO INTRODUCE HIGH IMPEDANCE LEAKAGE PATHS WITH GRAPHITE. (See Paragraph 5-8).

5-26. SUBSTITUTION. Troubleshooting is greatly simplified if checking is done by replacing assembly suspected of malfunction with a spare unit known to be operating correctly. Where the malfunctioning assembly is found, the faulty component can be replaced if practicable or the entire assembly shipped to a BLH Sales/Service Office for repair or replacement.

5-27. External Circuit.

5-28. Substitution of a BLH Model 625 Calibrator for the gages (Figure 5-9) at the front panel of the indicator will sectionalize the trouble to the gages, cabling and connections, or indicator. Set the calibrator to the output required and check indicator readout (1 mV/V = 2000 microinches per inch, See Table 5-3, Conversion Table Microinches Per Inch to mV/V). If the indicator output is correct for the range and step selected, the trouble lies with the external (strain gages) circuit.

5-29 Inspect length of cable or gage leads for breaks, cuts, or bruises. Check cable continuity in a weighing situation by moving the cable at the connector and by bending the cable in short loops while an observer monitors the indicator. If indicator readings are erratic or intermittent, replace entire cable assembly or lead. If the gages appear to be faulty, refer to the data supplied with the gages for troubleshooting.

5-30. Power Circuit.

5-31. UNLIT DISPLAY. (If display is lit see paragraph 5-37). If the display is unlit, begin with the power source and power cable. Check that instrument is plugged in and that power source voltage is reaching the receptacle; check power cord for breaks, cuts, and bruises. If power cord is intact, check fuse F1. If F1 is blown, carefully inspect the electrical connections in the system for shorts before replacing with a 0.3 ampere 250V time delay fuse (BLH # 128552-8, Buss MDL 0.3). Check power switch S1 by shorting the terminals with a test lead jumper.

5-32. Transformer T1 can be checked in the instrument. Measure voltage at the secondary windings with line power applied to the primaries. If the voltage is approximately 20VRMS and there are no primary-to-secondary short circuits, the trouble should be confined to the power supply board.

5-33. If malfunction is not listed in Table 5-2, disconnect the gages and substitute a known signal input, e.g., 625 Calibrator. Plug the instrument into a variable power transformer (Variac) and gradually lower the power input voltage to the lowest specified operating limit (103V for 115V instruments). This procedure will often cause marginal assemblies to fail completely or to indicate a malfunction listed in Table 5-2.

Table 5-2. Troubleshooting Aid

SYMPTOM	PROBABLE CAUSE	REMEDY
Blank (unlighted) display.	Power supply. Fuse F1, line switch, power transformer, dead batteries.	Replace defective components or power supply.
Superimposed digits.	IC drivers.	Replace defective driver.
Display drifts.	Auto-zero circuit.	Replace circuit board.
Saturated display in excess of overrange.	Defective cabling. Signal input or signal circuit open.	Check signal circuit.
Display indicates 00000 (no gain)	Shorted signal input.	Check signal input circuitry and gages.
Individual digits displayed erratically.	Decoder driver.	Replace defective driver.
Improper tracking (poor linearity)	Gages preamplifier.	Replace gages w/625 Calibrator; if condition remains, replace circuit board.
Intermittent or erratic operation.	Contaminated edge connectors.	Clean boards (Paragraph 5-7).

Table 5-3. Conversion Table

CONVERSION TABLE - MICROINCHES-PER-INCH TO MILLIVOLTS-PER-VOLT					
μ INCHES	Mv/V	μ INCHES	Mv/V	μ INCHES	Mv/V
0	0	1400	.70	4000	2.00
100	.05	1500	.75	4500	2.25
200	.10	1600	.80	5000	2.50
300	.15	1800	.90	5500	2.75
400	.20	2000	1.00	6000	3.00
500	.25	2200	1.10	6500	3.25
600	.30	2400	1.20	7000	3.50
700	.35	2500	1.25	7500	3.75
800	.40	2600	1.30	8000	4.00
900	.45	2800	1.40	8500	4.25
1000	.50	3000	1.50	9000	4.50
1200	.60	3500	1.75	9500	4.75
				10 000	5.00

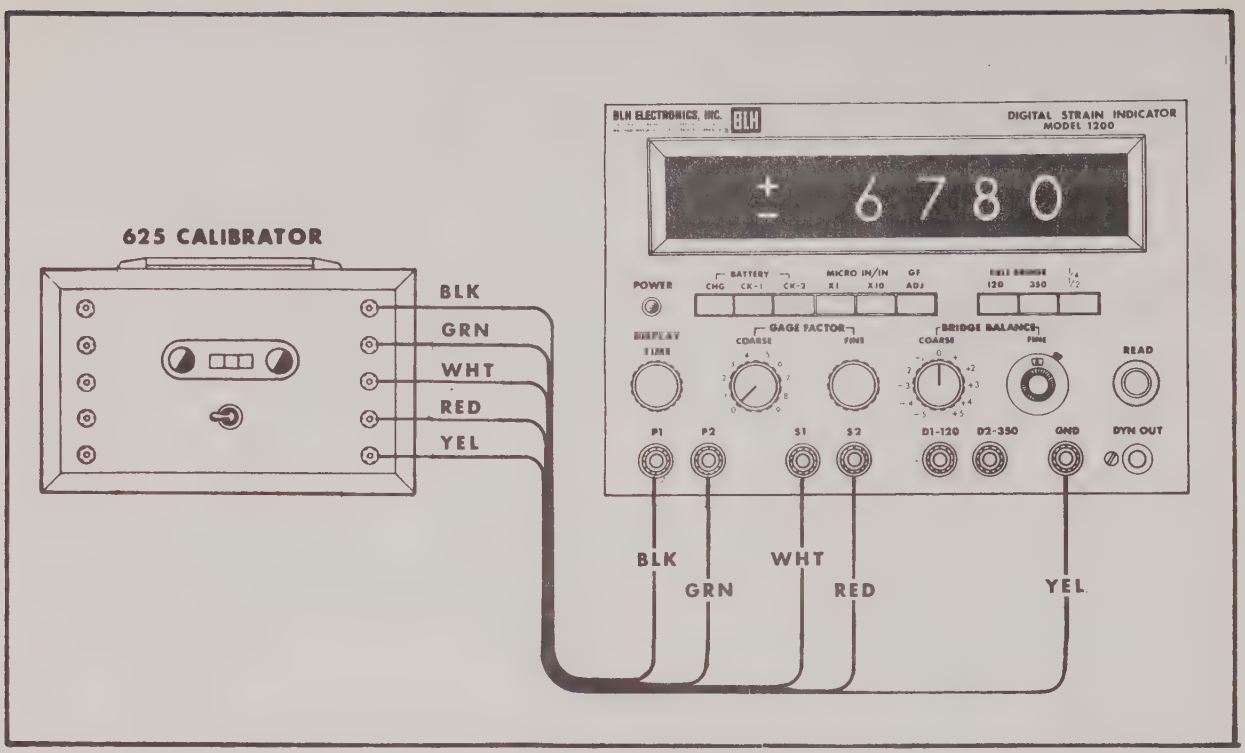


Figure 5-9. 625 Calibrator Connections

5-34. If the previous procedures are not effective, attempt to localize the malfunction by substitution (paragraph 5-26). Once identified as faulty, inspect the board for obvious, easily repairable, defects such as loose components or foil breaks . It is sometimes possible to determine a faulty IC by close inspection or by substitution. Carefully inspect the gold plating on the IC leads. It must show no peeling or blistering and there must be no evidence of corrosion on the body of the lead.

5-35. If the general appearance is satisfactory, protect the board and component from heat damage and swap the suspected IC for another of the same type. Check performance. If different conditions or symptoms are reversed (superimposed digits to next tube when drivers are switched) replace if available or order new IC.

5-36. If voltages are out of spec or non-existent push in firmly on the board and recheck the voltages. If results are negative, give the board a thorough visual inspection. Look for loose components or similar conditions which would indicate a trouble source. If no obvious fault is indicated during the visual inspection, replace the board as a unit. See paragraph 5-49 before repairing any printed circuit board.

5-37. LIT DISPLAY. (The following also applies to unlit display after proceeding through paragraphs 5-26.) If the display is lit, the power circuit through transformer T1 and the 180V portion of the supply can be eliminated as a potential trouble source. Check the 5 and 12V circuits on the power supply boards and the test points indicated in Figures 5-5 and 5-6. With the exception of the 180V circuit, (which may be as high is 200V unloaded) all dc voltages should be regulated and within ± 5% of the listed value over the specified live operating power of the instrument.

5-38. Signal Circuit.

5-39. Generally, a malfunctioning signal circuit component, (preamplifier, and converter, counter and latch and digital display) can be identified by one or more of the symptoms listed in Table 5-2. A thorough understanding of the operation and function of each circuit (see Section IV) will help in diagnosing malfunctions not immediately apparent from front panel indications.

5-40. REPAIR AND REPLACEMENT.

5-41. Field Replaceable Items.

5-42 Some of the items listed in the following paragraphs are recommended for field replacement only in emergencies. These items are indicated by asterisk (*). With the exception of easily repairable defects, (foil breaks, single components etc.) it is usually more econmical to return the entire instrument to the factory for repair and recalibration than to attempt extensive repairs.

5-43. Main Chassis.

5-44. BOARD REPLACEMENT*. Unless a main circuit board repair is a minor mechanical one, the entire board should be replaced as a unit. It is unusual for a single component to fail without affecting others and most massive failures are the result of extreme environmental conditions affecting the entire instrument. If the board must be replaced in the field, refer to Figure 5-2, proceed as follows:

a. Unplug instrument; unlatch and remove front cover (see paragraph 5-6).

b. Locate and remove the two rear panel 6-32 x 3/8 power supply retaining screws.

c. Withdraw power supply by drawing it directly to the rear as shown in Figure 5-2. If power supply does not move easily, rock it gently from side to side while pulling rearward.

d. When the power supply is removed, four chassis retaining screws are exposed. Remove.

e. Grasp front panel of indicator and withdraw chassis directly to the front as shown.

f. Unplug 22 pin edge connector from rear of main circuit board.

g. Locate and unscrew 6 slot head 6- 32 x 3/8 binder head circuit board retaining screws.

h. Lift board from chassis.

Install replacement in reverse sequence.

IMPORTANT

The instrument must be recalibrated when the board is installed.

5-45. IC REPLACEMENT. Three types of IC packages are used in the Model 1200: plug-in TO-116 flatpacks, soldered-in TO-116 flatpacks and soldered-in TO-99 packs. Do not attempt to replace the soldered-in type of IC unless shaped soldering irons are available and work is assigned to technicians familiar with replacement of these components.

5-46. Plug-in ICs should be removed with a commercially available extractor tool (Augat #T114-1 - see Figure 5-10). If a commercial extractor tool is not available, a substitute can be easily fabricated from a piece of scrap aluminum or steel.

5-47. When removing plug-in ICs, disconnect power from instrument if PC board is not removed and grasp ends of module with tool or fingers and draw steadily upward until leads are free of socket. Do not bend leads.

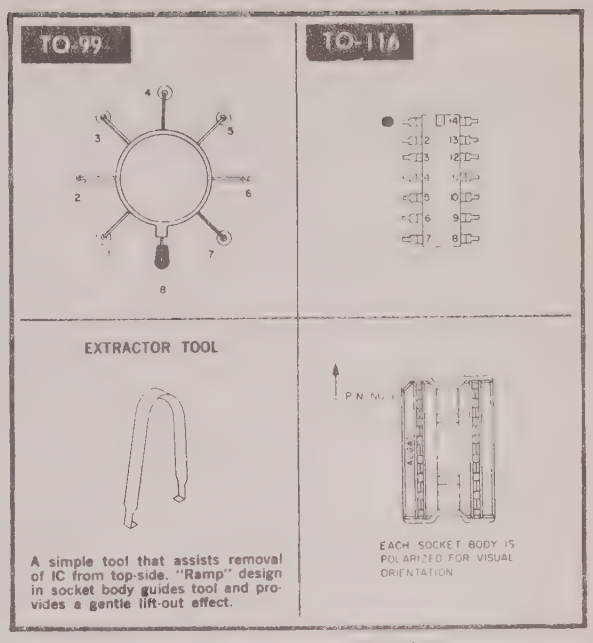

TO-99
TO-116
EXTRACTOR TOOL
A simple tool that assists removal of IC from top-side. "Ramp" design in socket body guides tool and provides a gentle lift-out effect.
EACH SOCKET BODY IS POLARIZED FOR VISUAL ORIENTATION

Figure 5-10. IC Polarity

5-48. Before replacing an IC, either plug-in or soldered-in type, check for proper alignment and polarity. For plug-in types, the notch or depression in the end of the flatpack body must be positioned toward the socket end with the beveled corner. Line up replacement IC with socket holes, set lightly into place and level carefully. Place thumb squarely on IC and press into place.

5-49. For soldered-in types of flatpacks, position the notched end toward the etched dot on the board. The dot signifies pin #1 of the circuit. On TO-99 packs, pin #8 is directly beneath the tab on the body of the IC. Align the tab over the elongated pad on the PC board.

5-50. TRANSISTOR REPLACEMENT. Transistors are inherently long-lived devices and should be replaced only when indicated as faulty. Do not check soldered-in transistors by substitution as the transistor or circuit board may be damaged. Leakage current from the soldering iron or a momentary short can permanently damage a transistor.

5-51. Refer to paragraph 5-33 before attempting to replace a transistor, then use a hot 50 watt or smaller iron. Apply heat to the leads of part to be replaced, NOT to the printed circuit on the board. Clean holes before installing the new transistor. Use long-nose pliers as a heat sink between the iron and transistor. Allow the transistor to cool before applying power to the unit.

5-52. SERVICING ETCHED CIRCUIT BOARD Excessive heat or pressure can lift the copper strip from the board. Avoid damage by using a low-power soldering iron (50 watts maximum) and following these instructions. Copper that lifts off the board should be cemented in place with a quick-drying acetate base cement having good electrical insulating properties. A break in the copper should be repaired by soldering a short length of tinned copper wire across the break. Use only high quality rosin core solder when repairing etched circuit boards. NEVER USE PASTE FLUX. After soldering, clean off any excess flux and coat the repaired area with a high quality electrical varnish or lacquer. When replacing components with multiple mounting pins such as transistors, electrolytic capacitors, and potentiometers, it will be necessary to lift each pin slightly, working around the component several times until it is free.

a. Apply heat sparingly to lead of component to be removed. If lead passes through an eyelet in the circuit board, apply heat on the component side. If lead does not pass through an eyelet, apply heat on the conductor side of board.

b. Reheat solder in vacant eyelet and quickly insert a wood sliver or toothpick to clean inside of hole.

c. Bend clean tinned leads on new component and carefully insert through eyelets or holes on board.

d. Hold part against board (avoid overheating) and solder leads. Apply heat to component leads on correct side of board as explained in step "a" above.

e. If the steps above are impractical or if the board has been damaged, clip the leads of the component to be removed close to the part itself leaving as long leads as possible still soldered to the board.

f. Straighten old leads and bend leads of new part around the protruding leads. Apply solder using a pair of long-nose pliers for a heat sink .

5-49. DISPLAY TUBE REPLACEMENT. The chassis must be removed from the case in order to replace the tubes. Remove chassis as follows:

a. Unplug instrument; unlatch and remove front cover (see paragraph 5-6).

b. Locate and remove the two rear panel 6-32 x 3/8 power supply retaining screws.

c. Withdraw power supply by drawing it directly to the rear as shown in Figure 5-2. If power supply does not move easily, rock it gently from side to side while pulling rearward.

d. When the power supply is removed, four chassis retaining screws are exposed. Remove.

e. Grasp front panel of indicator and withdraw chassis directly to the front as shown.

Pull and replace defective tube with Amperex ZM 1000 (BLH # 138519-8).

IMPORTANT

THE BASES OF READOUT TUBES AND THE TUBE SOCKETS ARE NOT KEYED. IT IS POSSIBLE TO INSTALL A TUBE INCORRECTLY OR BACKWARDS. CHECK THAT NUMERALS ARE DIRECTLY TO THE FRONT BEFORE INSTALLATION.

5-53. POLARITY DISPLAY ASSEMBLY. The individual neon lamps in the polarity display assembly are cemented into the housing and cannot be replaced. The entire assembly is designed to be replaced as a unit. Proceed as follows:

a. Unplug instrument; unlatch and remove front cover (see paragraph 5-6).

b. Locate and remove the two rear panel 6-32 x 3/8 power supply retaining screws.

c. Withdraw power supply by drawing it directly to the rear as shown in Figure 5-2. If power supply does not move easily, rock it gently from side to side while pulling rearward.

d. When the power supply is removed, four chassis retaining screws are exposed. Remove.

e. Grasp front panel of indicator and withdraw chassis directly to the front as shown.

f. Unplug 22-pin edge connector from rear of main circuit board.

g. Locate and unscrew six slot head 6-32 x 3/8 circuit board retaining screws.

h. Lift board from chassis.

i. Unsolder lamp wires from turret lugs 1, 2, 3, and 4.

j. Turn board upside down, locate and remove two 4-40 x 5/16 display assembly retaining screws.

k. Turn board upright and unsolder lamp wires from turret lugs 5 and 6.

l. To replace, wire the leads to the turret lugs in the correct sequence (wire identification is etched into the PC board).

m. Secure assembly to circuit board with two 4-40 x 5/16 display assembly retaining screws.

n. Reassemble instrument in reverse order of disassembly.

NOTE

Neon lamps of this type require a 24 hour burn-in period before functioning to full capacity. During the burn-in, the lamp will be lit to approximately 50% brilliance and the diminished glow will appear to "walk" the length of the two electrodes. The glow will eventually elongate and stabilize at the end of the burn-in period.

5-54. POWER LAMP REPLACEMENT. The Power indicator lamp, DS1, is a light-emitting-diode cemented in place with glyptal. It should last the life of the instrument. If, however, the lamp is damaged or becomes defective, replace as follows:

a. Unplug instrument; unlatch and remove front cover (see paragraph 5-6).

b. Locate and remove the two rear panel 6-32 x 3/8 power supply retaining screws.

c. Withdraw power supply by drawing it directly to the rear as shown in Figure 5-2. If power supply does not move easily, rock it gently from side to side while pulling rearward.

d. When the power supply is removed, four chassis retaining screws are exposed. Remove.

e. Grasp front panel of indicator and withdraw chassis directly to the front as shown.

f. Unplug 22-pin edge connector from rear of main circuit board.

g. Locate and unscrew six slot head 6-32 x 3/8 circuit board retaining screws.

h. Lift board from chassis.

i. Pad the face of the lamp with cardboard or a small square of foam rubber and knock the defective lamp out through the rear of the front panel with a 1/8" pin punch.

j. Unsolder the leads from terminals P1 and P2. (Note that there is a 300Ω CC resistor in series with the P2 lead. Check and replace if necessary before soldering and cementing in the new lamp. Monsanto Electronic Special Product # mV10B.)

k. Reassemble instrument.

5-55. SWITCH AND CONTROL REPLACEMENT. All front panel controls and switches are fastened to the front panel with a combination of lock washers, nuts and machine screws. Replacement of front panel components requires that the front panel of the instrument be removed. Refer to Figure 5-11 and proceed as follows:

a. Unplug instrument; unlatch and remove front cover (see paragraph 5-6).

b. Locate and remove the two rear panel 6-32 x 3/8 power supply retaining screws.

c. Withdraw power supply by drawing it directly to the rear as shown in Figure 5-2. If power supply does not move easily, rock it gently from side to side while pulling rearward.

d. When the power supply is removed, four chassis retaining screws are exposed. Remove.

e. Grasp front panel of indicator and withdraw chassis directly to the front as shown.

f. Unplug 22-pin edge connector from rear of main circuit board.

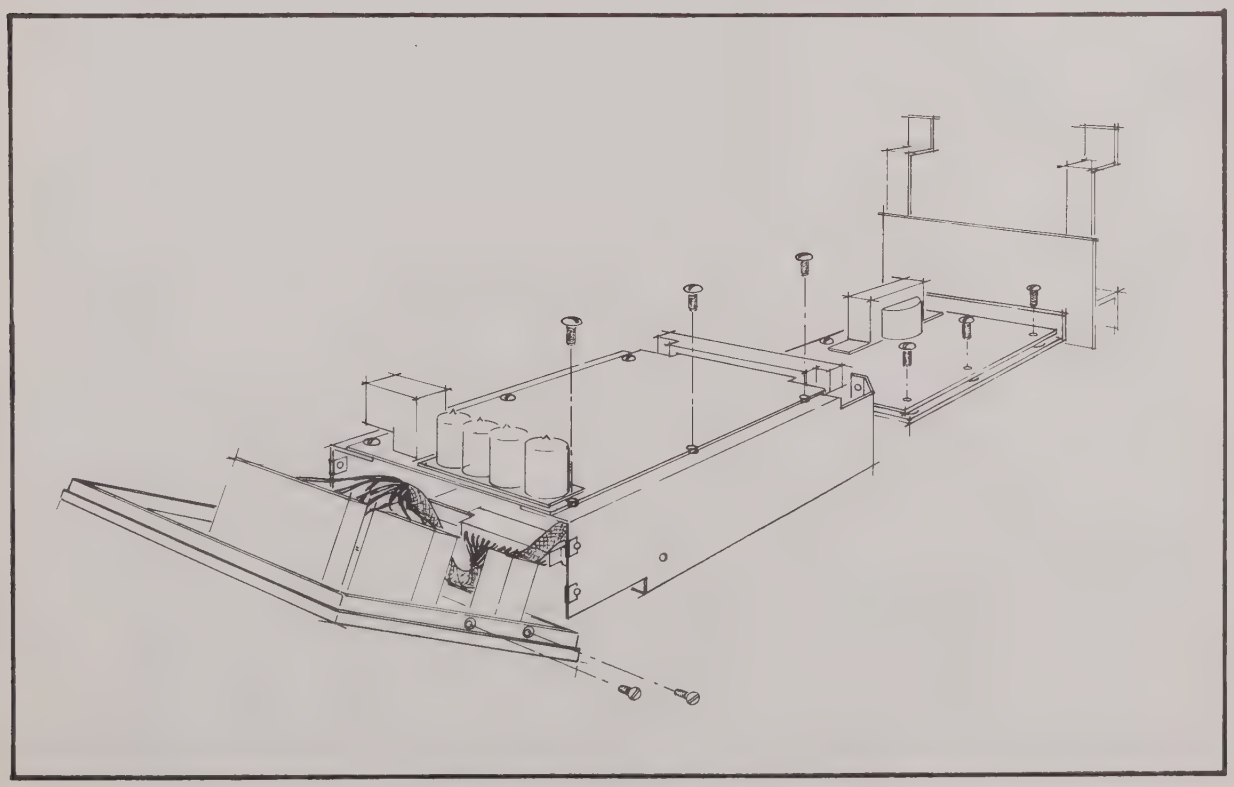


Figure 5-11. Front Panel Removal

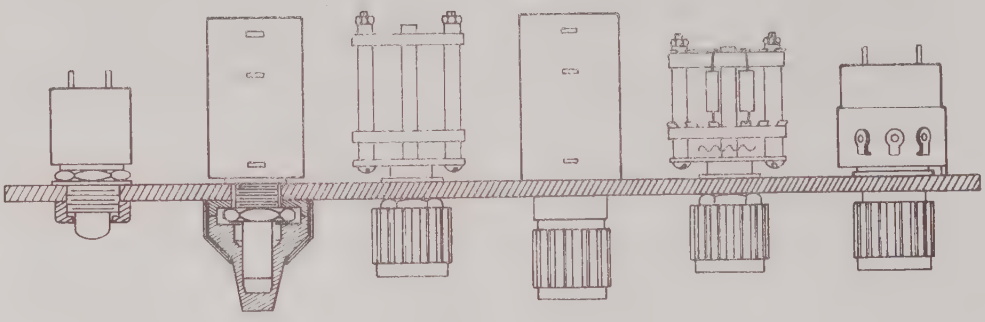


Figure 5-12. Switch and Control Location

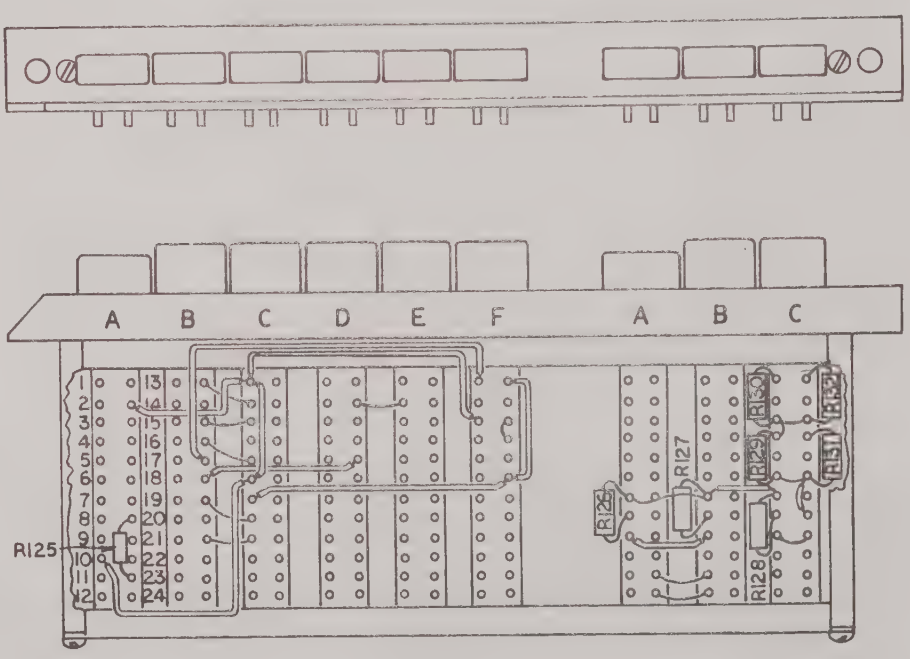


Figure 5-13. Resistor and Jumper Location

g. Locate and unscrew six slot head 6-32 x 3/8 circuit board retaining screws

h. Lift board from chassis.

i. Locate and unscrew 4 (2 on each side) 6-32 x 3/8 flat head chassis-to-front-panel retaining screws.

j. Pivot front panel forward as shown in Figure 5-10. Refer to Figure 5-12 during mounting and dismounting of front panel components. Do not attempt to replace a part of any switch or control (single deck, resistor, etc) replace as a unit. Before disassembly note color code and pin position of switch wiring. The pushbutton switch banks should be replaced as a unit with jumpering and resistors positioned as shown in Figure 5-13.

5-56. Power Supplies.

5-54. BATTERY REPLACEMENT. Battery operated instruments are powered by eight 1.2V rechargeable nickel cadmium size RR dry cells. Four batteries from a +4.8V supply for the digital logic supply. The remaining four form a -4.8V bridge power supply. The level of charge in the batteries is indicated in the digital display when the BATTERY CHK 1 or the BATTERY CHK 2 switches are pressed. A reading below 4100 indicates the batteries should be recharged. If, after 24 hours on charge, the batteries cannot be brought above 4100, replace as follows:

a. Unplug instrument; unlatch and remove front cover (see paragraph 5-6).

b. Locate and remove the two rear panel 6-32 x 3/8 power supply retaining screws.

c. Withdraw power supply by drawing it directly to the rear as shown in Figure 5-2. If power supply does not move easily, rock it gently from side to side while pulling rearward.

d. Snap the batteries upward out of the clips. When replacing observe the polarity indicator etched on the surface of the board. Replace with Gulton R125, size RR (BLH # 138542-8).

5-58. POWER CORD REPLACEMENT. Both the battery and ac operated instruments are equipped with an eight-foot, three-conductor power cable. When replacing, note lead connection points. The green lead is the ground lead and must be connected to the case. Removal and replacement of the power cable requires that the power supply be removed.

a. Compress strain relief inside case with special tool if available or with pliers and push out of mounting hole.

b. Prepare new cable for installation (tin wires, etc.)

c. Thread new cable through strain relief and reinstall in power supply chassis, leave approximately two inches of sheathed cable inside case in addition to six inches of stripped, tinned, leads.

d. Press strain relief into mounting hold to secure

e. Solder new cable to proper connection points.

5-59. TRANSFORMER REPLACEMENT. Transformer T1 and T2 can be replaced without removing the power supply etched circuit board. Before removing, tag each lead - both primary and secondary- with the corresponding transformer coil lead identification number. When unsoldering protect nearby components and etched circuit board from heat damage (see paragraph 5-40).

5-60. FUSE REPLACEMENT. Electrically, the entire instrument forward of the input side of the line filter is protected by a 0.3A 250V, time-delay fuse. The fuse (F1) is the only one in the instrument and is physically located in a fuse holder on the lower rear panel of the power supply. Replace with BLH# 128532-8 (Buss, MDL 0.3) after first determinings, and rectifying cause of overload.

5-61. CALIBRATION

5-62. General

5-63. The Indicator measuring circuits contain both fixed, and high stability, precision wire-would resistors and solid-state components operated well below their maximum ratings. Once adjusted at the factory, the Indicator seldom requires recalibration. This calibration procedure IS NOT RECOMMENDED FOR A ROUTINE OR INCOMING QUALITY CONTROL CHECK. Use the check outlined in Figure 2-11 for these checks.

5-64. If however, a component fails and is replaced, or if for other reasons, the accuracy of the Indicator is in doubt, calibration should be checked and if necessary, adjusted as described below. During calibration, refer to Figures 2-13, Internal Control Data; 5-3, Component Location; 5-4, Test Point Location; 5-5, DC Power Supply Component Location and Voltage Levels; and 5-6, AC Power Supply Component Location and Voltage Levels.

5-65. Calibration Procedure.

1. Remove the chassis as described in paragraph 5-8.

2. Plug in the power cord from the AC power pack.

3. Connect Model 1200 Indicator to a Model 625 Calibrator, 350Ω terminals (very short leads) BK to P1, GRN to P2, RED to S-1, WH to S-2.

4. Set the Model 1200 to 350Ω, FULL BRIDGE position and X1 range.

5. Set the COARSE GAGE FACTOR switch to 2000, the FINE GAGE FACTOR fully counterclockwise.

6. Set the COARSE BRIDGE BALANCE switch to 0 and the FINE BRIDGE BALANCE to 500.

7. Set Calibrator to 0 mv/v. Insert a scope plug in the DYN OUT jack. (See paragraph 2-68 for plug specifications.)

8. Apply instrument power with DISPLAY TIME/ON control.

9. Connect a voltmeter with a minimum resolution of 10 mv across the dynamic output terminals and adjust R119, DYNAMIC ZERO ADJUSTMENT until the dynamic output is less than ±0.10V.

10. Disconnect scope plugs.

11. With a clip lead jumper, connect TP4 to TP8 and connect a DVM with a minimum resolution of 1 mv between TP5 and TP8 (grd).

12. Adjust R100 (REFERENCE AMPLIFIER ZERO) until voltmeter reads 0 ±1 mv.

13. Remove jumper from TP4 and connect it across TP10 and TP8 (grd).

14. With Calibrator at 0 mv/v, record instrument readout.

15. Change calibrator setting to 5 mv/v. Record reading. Compute span by correcting reading by the amount recorded in step 14. i.e. If reading recorded in step 14 was #10 counts, SUBTRACT it from the reading obtained in step 15. If reading obtained in step 14 was -10 counts, ADD it to the figure in step 15.

16. Reverse output leads (white & red) on the 625 Calibrator and repeat steps 14 & 15.

17. Adjust POSITIVE REFERENCE ADJ. pot R99 until the span obtained in step 16 is equal to the span obtained in step 15.

18. Connect jumper between P2A and TP8.

19. Adjust INTEGRATOR ZERO ADJ., R124, until indicator reads 0000±0001.

20. Remove jumper.

21. Disconnect Model 625 Calibrator from the Indicator and connect resistors simulating half-bridge configuration according to the instructions in Section II.

22. Push 1/2, 1/4 Bridge Switch.

23. Zero initial unbalance with COARSE and FINE ZERO adjustment controls.

24. Jumper White and Red terminals on the front panel of the indicator with a short clip lead.

25. With the MICRO IN/IN push button at X1 position, adjust AMPLIFIER ZERO ADJ., R94, until indicator reads 0000±0001.

26. Press X10 pushbutton and record reading.

27. Remove jumper from the White and Red terminals, re-zero the indicator X1 range (if necessary) and repeat steps 25 and 26. The reading in steps 25 & 26 should be within ±1-2 counts.

28. Connect Model 625 Calibrator to the Indicator at full bridge configuration as in step 3.

29. Set gage factor to 2000 with COARSE and FINE adjustments.

30. Zero instrument with FINE BRIDGE BALANCE control, X1 range.

31. Set Calibrator to 4 mv /v and adjust R87 (X1 gain) to indicate 8000±0002.

32. Set indicator to GF = 2.000 and X10 range, check zero and adjust R88 (X10 gain) to read 0800±0001 for 4 mv/v input.

33. Reverse output leads on the calibrator and recheck steps 31 & 32. If the positive and negative outputs are not equal, readjust R87 and R88 , reverse output leads and trim R99. Recheck GF and reset if necessary.

34. Set instrument to X1 range and GAGE FACTOR to 2000. Change Calibrator output from 0 to 10 mv/v and check linearity as described in figure 2-11.

35. Turn off instrument power.

36. Remove AC power pack and install battery pack.

37. Turn on instrument power.

38. Connect DVM across the negative battery supply.

39. Set battery check switch at CK-1 position.

40. Press read switch.

41. Adjust R7 on the power supply card until DVM and readout indicate the same voltage (±50 mv).

42. Check + battery voltage (CK-2). Batteries voltages should be above 4.1V.

43. Set range switch to X1 and recheck steps 21 thru 34.

5-66. Calibration with Model 1225 Switching and Balancing Unit.

5-67. When the indicator is used with the Model 1225, indicator calibration must be preformed THROUGH the Model 1225. Connect the Model 625 calibrator to any channel of the Model 1225 as a four-arm bridge connection as shown in Figure 2-6 of the 1225 manual. Connect the Model 1225 to the Model 1200 as shown in the same illustration.

NOTES

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for identifying and ordering replacement parts. The overall schematic diagram of the instrument and parts locator (reverse side) is included at the rear of this manual. Table 6-1 lists in alphanumeric order by reference designator and provides the following information on each part;

a. BLH part number.

b. Total quantity used in the instrument (TQ) column). Quantity listed where item first appears on list.

c. Recommended spares for year application in a remote location (or 2000 hours). RS column.

6-3 ORDERING INFORMATION.

6-4. To obtain replacement parts, address order or inquiry for parts to the nearest BLH Sales/Service Office (see list at rear of this manual) or direct to BLH. Identify parts by BLH part number.

To order

6-5. To order parts not listed on this section provide the following:

a. Model number of instrument.

b. Serial number of the unit.

c. Description of the part including function and location.

DESIGNATORS

A	= assembly	F	= fuse	P	= plug	TC	= thermocouple
B	= motor	FL	= filter	Q	= transistor	V	= vacuum tube, neon bulb, photocell etc.
BT	= battery	HR	= heater	QCR	= transistor-diode	W	= cable
C	= capacitor	J	= jack	R	= resistor	X	= socket
CR	= diode	K	= relay	RT	= thermistor	XDS	= lampholder
DL	= delay line	L	= inductor	S	= switch	XF	= fuseholder
DS	= lamp	M	= meter	T	= transformer	Z	= network
E	= misc electronic part	MP	= mechanical part	TB	= terminal board		

ABBREVIATIONS

A	= ampere (s)	H	= henry (ies)	nA	= nanoampere (s) = 10^{-9}	Se	= selenium
Ag	= silver	Hg	= mercury	NC	= normally closed	sect	= section (s)
Al	= aluminum	Hz	= cycles per second	Ne	= neon	Si	= silicon
Au	= gold			NO	= normally open	sl	= slide
		ID	= inside diameter	NPO	= negative positive zero (zero temperature coefficient)	SPDT	= single-pole double-throw
C	= capacitor	impg	= impregnated			SPST	= single-pole single-throw
cer	= ceramic	incd	= incandescent	ns	= nanosecond (s) = 10^{-9}		
coef	= coefficient	ins	= insulation (ed)			Ta	= tantalum
com	= common			Ω	= ohm (s)	tog	= toggle
comp	= composition	KΩ	= kilohm (s) = 10^{+3}	OD	= outside diameter	tol	= tolerance
conn	= connection	kg	= kilogram			trim	= trimmer
		KHz	= kilocycle (s) = 10^{+3}	p	= peak	TSTR	= transistor
dep	= deposited			pc	= printed circuit		
DPDT	= double-pole double-throw	L	= indicator	pF	= picofarad (s) = 10^{-12}	V	= volt (s)
		lin	= linear taper	piv	= peak inverse voltage	vacw	= alternating current working volt (s)
DPST	= double-pole single-throw	log	= logarithmetic taper	p/o	= part of	var	= variable
		m	= milli = 10^{-3}	pos	= position (s)	vdcw	= direct current working volt (s)
elect	= electrolytic	mA	= milliampere (s) = 10^{-3}	poly	= polystyrene		
encap	= encapsulated	mH	= millihenry (s) = 10^{-3}	pot	= potentiometer	W	= watt (s)
		MHz	= megacycle (s) = 10^{+6}	p-p	= peak-to-peak	w/	= with
F	= farad (s)	MΩ	= megohm (s) = 10^{+6}	prec	= precision (temperature coefficient, long term stability, and/or tolerance.)	w/o	= without
FET	= field effect transistor	met film	= metal film			ww	= wirewound
fxd	= fixed	mfr	= manufacturer				
		mtg	= mounting			*	= optimum value selected at factory, average value shown (part may be omitted)
GaAs	= gallium arsenide	μ	= micro = 10^{-6}	R	= resistor		
GHz	= gigacycle (s) = 10^{+9}	my	= Mylar®	rms	= root-mean-square		
gd	= guard			rot	= rotary		
Ge	= germanium						
grd	= ground (ed)						

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Table 6-1. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
END ITEM	415630-4			Model 1200 Digital Strain Indicator Less Power Supply		
A1	415615-3		1	Assembly, Front Panel		
A2	415629-4		1	Assembly, Chassis and Frame		
A3	415600-3		1	Assembled Case/Rear Panel		
A4	418680-2		1	Assembled Cover		
A5	415599-3		1	Power Supply - AC		
A5	416176-3		1	Power Supply - Battery		
A1	415615-3		1	Assembly, Front Panel		
A1A1	415623-2		1	Assembly, Pushbutton switch (Function Switch S1, S2)		
A1A2	415622-2		1	Assembly, Gage Factor Switch		
A1A3	416208-2		1	Assembly, Coarse Bridge Switch		
A1DS1			1	Lamp, 3V Monsanto Electronic		MV10B
A1J1			1	Jack (DYN OUT) Switchcraft		MT339
A1MP1	415406-2		1	Front Panel		
MP2	412568-1		1	Bezel Kit		
MP3	138261-8		2	Knob (S5)		
MP4				Same as MP3 (S6)		
MP5	138262-8		1	Knob (R101)		
MP6	139444-8		1	Knob (R102)		
MP7	135149-8		1	Post, Binding, Black		
MP8	135150-8		1	Post, Binding, Green		
MP9	135146-8		1	Post, Binding, White		
MP10	135145-8		1	Post, Binding, Red		
MP11	139459-8		2	Post, Binding, Blue		
MP12				Same as MP11		
MP13	135148-8		1	Post, Binding, Yellow		
A1R101	415614-1		1	R: Variable (DISPLAY TIME)		
R102	128645-8		1	R: Variable 10K, ± 5%		
R103	128643-8		1	R: Variable 1K		
	141545-8		1	Duo-Dial (P/O R103) Helipot		
A1S3	137676-8		1	Switch, Pushbutton, DPST		
S4			1	Switch, ac (P/O R101)		
A1A1	415623-2		1	Assembly, Pushbutton Switch		
A1A1MP1	415248-2		1	Bracket		
A1A1R126	138551-8		1	R: 12K, W.W. 1/8W, 0.5%		
R127	138396-8		1	R: 35K, W.W. 1/8W, 0.5%		
R128	138554-8		1	R: 50K, W.W. 1/8W, 0.5%		
R129	418579-1		2	R: 500Ω, W.W. 1/8W, 0.5%		
R130	418578-1		1	R: 350Ω, W.W. 1/8W, 0.5%		
R131				R: Same as R129		
R132	418577-1		1	R: 120Ω, W.W. 1/8W, 0.5%		

Table 6-1. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
A1A1S1	415404-1		1	Switch, Pushbutton		
S2				Switch P/O S1		
A1A2	415622-2		1	Assembly, GAGE FACTOR switch		
A1A2R201	139240-8		1	R: 6.04K, 1/8W, 1%, Dale		MF 1/10
R202	139259-8		8	R: 9.09K, 1/8W, 1%, Dale		MF 1/10
R203				Same as R202		
R204				Same as R202		
R205				Same as R202		
R206				Same as R202		
R207				Same as R202		
R208				Same as R202		
R209				Same as R202		
A1A2S5	415621-1		1	Switch, Rework and Assembly		
A1A3	416208-2		1	Assembly, COARSE BRIDGE switch		
A1A3R301	136735-8		12	R: 450Ω, W.W. 1/10W		
R302				Same as R301		
R303				Same as R301		
R304				Same as R301		
R305				Same as R301		
R306				Same as R301		
R307				Same as R301		
R308				Same as R301		
R309				Same as R301		
R310				Same as R301		
R311				Same as R301		
R312				Same as R301		
A1A3S6	403546-1		1	Switch, Rework and Assembly		
A2	415629-4		1	Assembly, Chassis and Frame		
A2A1	418186-3		1	Assembly, PC Board		
A2A2	418463-2		1	Assembly, Polarity Display		
A2MP1	415586-4		1	Chassis		
MP2	417370-2		1	Frame		
A2W1	416138-4		1	Assembly, Cable and Connectors		
A2A1	418186-3		1	Assembly, PC Board		
	415334-3		1	PC Board		
A2A1C1				C: NOT USED		
C2	138517-8		1	C: 0.033μF, 100V		
C3	141247-8		2	C: 0.0047μF, 600V		

Table 6-1. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
A2A1C4	138511-8		1	C: 15μF, 12V		
C5	138534-8		1	C: 0.1μF, 1000V		
C6				NOT USED		
C7				Same as C3		
C8	138516-8		4	C: 10μF, 20V		
C9	139010-8		2	C: 47μF, 20V		
C10				Same as C9		
C11				Same as C8		
C12				Same as C8		
C13	137834-8		6	C: 47pf, 500V		
C14				Same as C13		
C15				Same as C13		
C16	137853-8		1	C: 0.47μF, 100V		
C17	141905-8		12	C: 0.01μF, 1000V		
C18	137837-8		1	C: 0.47μF, 50V		
C19				C: NOT USED		
C20				C: NOT USED		
C21				Same as C13		
C22				Same as C13		
C23				Same as C13		
C24	139464-8		1	C: 1μF, 100V		
C25	138518-8		1	C: 330pF, 1000V		
C26-C35				Same as C17		
C36				Same as C8		
C37	139558-8		2	C: 0.001μF, 500V		
C38				Same as C37		
C39	138499-8		1	C: 100pF, 500V		
C40				Same as C17		
A2A1CR1				Diode: NOT USED		
CR2	137739-8		22	Diode: IN914		
CR3				Same as CR2		
CR4				Same as CR2		
CR5				Same as CR2		
CR6				Same as CR2		
CR7				Same as CR2		
CR8				Same as CR2		
CR9				Same as CR2		
CR10				Same as CR2		
CR11				Same as CR2		
CR12				Same as CR2		
CR13				Same as CR2		
CR14				Same as CR2		
CR15				Same as CR2		
CR16				Same as CR2		
CR17	412515-1		2	Diode: IN34A		
CR18	137989-8		5	Diode: IN4148		
CR19				Same as CR18		
CR20				Same as CR18		
CR21				Same as CR18		
CR22				Same as CR18		

Table 6-1. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
CR23	137976-8			Diode: FD300		
CR24				Same as CR23		
CR25				Same as CR2		
CR26				Same as CR2		
CR27	137808-8		1	Diode: IN5234		
CR28				Same as CR2		
CR29				Same as CR17		
CR30				Same as CR2		
CR31				Same as CR2		
CR32				Same as CR2		
CR33				NOT USED		
CR34				Optional, Used with Scanner		
CR35				Optional, Used with Scanner		
CR36				NOT USED		
CR37				Same as CR2		
CR38	139495-8		1	Diode: IN5232B		
A2A1IC1	137446-8		3	Integrated Circuit: SN158094N		
IC2	137464-8		3	Integrated Cirucit: SN15849N		
IC3				Same as IC2		
IC4				Same as IC1		
IC5	137984-8		4	Integrated Circuit: SN744IN		
IC6				Same as IC5		
IC7				Same as IC5		
IC8				Same as IC5		
IC9				Same as IC1		
IC10	138515-8		4	Integrated Circuit SN7475N		
IC11				Same as IC10		
IC12				Same as IC10		
IC13				Same as IC10		
IC14	138514-8		4	Integrated Circuit SN7490N		
IC15				Same as IC14		
IC16				Same as IC14		
IC17				Same as IC14		
IC18	138513-8		1	Integrated Circuit U6A901659X		
IC19				Same as IC2		
IC20	137743-8		3	Integrated Circuit μL914		
IC21				Same as IC20		
IC22				Same as IC20		
IC23	137908-8		3	Integrated Circuit μA741		
IC24	137852-8		1	Integrated Circuit LM301A		
IC25				Same as IC23		
IC26				Same as IC23		
IC27	137463-8		1	Integrated Circuit LM311		
A2A1Q1				NOT USED		
Q2	138150-8		1	Transistor: 2N2646		
Q3	136751-8		11	Transistor: 2N3903		
Q4				Same as Q3		
Q5				Same as Q3		
Q6				Same as Q3		
Q7	136752-8		3	Transistor: 2N3905		

Table 6-1. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
A2A1Q8				Same as Q3		
Q9				Same as Q3		
Q10				Same as Q7		
Q11				Same as Q3		
Q12				Same as Q3		
Q13				Same as Q7		
Q14	137990-8		3	Transistor: 2N4410		
Q15				Same as Q14		
Q16				Same as Q14		
Q17	137800-8		1	Transistor: 2N3904		
Q18	137830-8		6	Transistor: U1899E		
Q19				Same as Q18		
Q20				Same as Q18		
Q21	137854-8		3	Transistor: U232		
Q22	278512-1		1	Transistor: A1535		
Q23				Same as Q3		
Q24				Same as Q3		
Q25	403443-1		2	Transistor: A641L (Matched Pair)		
Q26				Same as Q25		
Q27			1	Same as Q21		
Q28				Same as Q18		
Q29				Same as Q18		
Q30				Same as Q18		
Q31				Same as Q21		
Q32				Same as Q3		
A2A1R1				NOT USED		
R2				NOT USED		
R3				NOT USED		
R4				NOT USED		
R5				NOT USED		
R6	138666-8		2	R: 562Ω, 1/8W, 1%		
R7				Same as R6		
R8	129836-9		1	R: 200Ω CC, 1/2W, 5%		
R9	129877-8		6	R: 10K CC, 1/2W, 5%		
R10	129860-8		3	R: 2K CC, 1/2W, 5%		
R11	129899-8		1	R: 82K CC, 1/2W, 5%		
R12	129857-8		1	R: 1.5K CC, 1/2W, 5%		
R13	129863-8		1	R: 2.7K CC, 1/2W, 5%		
R14	129884-8		5	R: 20K CC, 1/2W, 5%		
R15	129853-8		4	R: 1K CC, 1/2W, 5%		
R16				Same as R15		
R17				Same as R15		
R18	129839-2		2	R: 270Ω CC, 1/2W, 5%		
R19	129881-8		1	R: 15K CC, 1/2W, 5%		
R20				Same as R10		
R21				Same as R10		
R22	129870-8		11	R: 5.1K CC, 1/2W, 5%		
R23	129894-8		14	R: 51K CC, 1/2W, 5%		
R24				Same as R22		
R25				Same as R23		
R26				Same as R22		
R27	129885-8		4	R: 22K CC, 1/2W, 5%		

Table 6-1. Replaceable Parts

Ref Desig	BLH Part No	RS	TQ	Description	Mfr	Mfr Part No.
A2A1R28				Same as R22		
R29				Same as R23		
R30				Same as R22		
R31				Same as R23		
R32				Same as R22		
R33				Same as R27		
R34				Same as R22		
R35				Same as R23		
R36				Same as R22		
R37				Same as R23		
R38				Same as R22		
R39				Same as R27		
R40				NOT USED		
R41				Same as R23		
R42				Same as R23		
R43				Same as R23		
R44				Same as R23		
R45				Same as R23		
R46				NOT USED		
R47	129949-8		4	R: 10MΩ CC, 1/2W, 5%		
R48	129888-8		1	R: 30K CC, 1/2W, 5%		
R49				Same as R47		
R50				NOT USED		
R51				Same as R47		
R52				NOT USED		
R53				Same as R47		
R54				Same as R14		
R55				Same as R22		
R56				Same as R14		
R57				Same as R14		
R58				NOT USED		
R59	129829-8		1	R: 100Ω CC, 1/2W, 5%		
R60				Same as R22		
R61				NOT USED		
R62				Same as R15		
R63				Same as R18		
R64	129845-8		1	R: 470Ω CC, 1/2W, 5%		
R65				Same as R23		
R66				Same as R23		
R67				NOT USED		
R68				NOT USED		
R69	138397-8		2	R: 5K WW, 1/8W, 0.5%		
R70				Same as R69		
R71	129862-8		1	R: 2.4K CC, 1/2W, 5%		
R72				Same as R9		
R73				Same as R9		
R74	129901-8		2	R: 100K CC, 1/2W, 5%		
R75				Same as R74		
R76				Same as R27		
R77				Same as R9		
R78	138855-8		4	R: 49.9K FF, 1/8W, 1%		
R79				Same as R78		

Table 6-1. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
A2A1R80	138398-8		2	R: 8.5K WW, 1/8W, 0.5%		
R81	138728-8		1	R: 2.49K FF, 1/8W, 1%		
R82	138805-8		1	R: 15K FF, 1/8W, 1%		
R83	138394-8		1	R: 775Ω WW, 1/8W, 0.5%		
R84				Same as R80		
R85	138395-8		2	R: 4K WW, 1/8W, 0.5%		
R86	138396-8		1	R: 35K WW, 1/8W, 0.5%		
R87	139542-8		2	R: Variable 50K		
R88				Same as R87		
R89				Same as R85		
R90				Same as R23		
R91	129905-8		2	R: 150K, 1/2W, 5%		
R92				Same as R91		
R93				Same as R14		
R94	139555-8		1	R: Variable 20K		
R95	138662-8		2	R: 511Ω FF, 1/8W, 1%		
R96	138399-8		2	R: 20K WW, 1/8W, 0.5%		
R97	138817-8		3	R: 20K FF, 1/8W, 1%		
R98				Same as R96		
R99	139541-8		3	R: Variable 1K		
R100	139540-8		1	R: Variable 10K		
R101	138880-8		1	R: 90.9K FF, 1/8W, 1%		
R102				NOT USED		
R103	138698-8		1	R: 1.21K FF, 1/8W, 1%		
R104				Same as R78		
R105				Same as R78		
R106				NOT USED		
R107	138757-8		2	R: 4.99K FF, 1/8W, 1%		
R108				Same as R107		
R109				NOT USED		
R110	129837-8		1	R: 220Ω CC, 1/2W, 5%		
R111				Same as R9		
R112				Same as R9		
R113				Same as R97		
R114				Same as R97		
R115	129869-8		1	R: 4.7K, 1/2W, 1%		
R116	139481-8		1	R: 1.5MΩ FF, 1/8W, 1%		
R117				Same as R95		
R118	138884-8		1	R: 100K, 1/8W, 1%		
R119				Same as R99		
R120	138793-8		1	R: 11.3K FF, 1/8W, 1%		
R121	138826-8		1	R: 24.9K FF, 1/8W, 1%		
R122	138748-8		1	R: 4.02K FF, 1/8W, 1%		
R123	129821-8		1	R: 47Ω CC, 1/2W, 5%		
R124				Same as R99		
R125	129541-8		1	R: 560Ω, 1/4W, 5%		
R126	129571-8		1	R: 10K, 1/4W, 5%		
R127	129563-8		1	R: 4.7K, 1/4W, 5%		
R128	129643-8		1	R: 10MΩ, 1/4W, 5%		
R129	129635-8		1	R: 4.7MΩ, 1/4W, 5%		
A2A1V1-V4	138519-8		4	Tube, Counter		
A2A1XV1-XV4	138520-8		4	Socket, Tube		

Table 6-1. Replaceable Parts

Ref Desig	BLH Part No	RS	TQ	Description	Mfr	Mfr Part No.
A3	415600-3		1	Assembly Case/Rear Panel		
A3A1	418220-2		1	Assembly, Rear Panel		
A3MP1	415594-3		1	Case		
MP2	413612-3		1	Frame		
MP3	403508-1		1	Feet and Bail Kit		
A4	418680-2		1	Assembled, Cover		
A5	415599-3		1	Power Supply, AC		
A5A1	415610-2		1	Assembly, Printed Circuit Board (ac)		
A2	415589-2		1	Assembly, Panel and Bracket		
A5F1	128588-8		1	Fuse: 1/4 amp AGC		
A5MP1	415909-2		1	Insulator		
A5S1	403692-1		1	Switch, Slide 115-230V		
A5W1	409549-1		1	A.C. Cable		
A5XF1	131050-8		1	Fuseholder		
A5A1	415610-2		1	Assembly, PC Board (ac)		
	415611-2		1	P.C. Board		
A5A1C1	137793-8		1	C: 4μF, 250V		
C2	137820-8		2	C: 350μF, 35V		
C3				Same as C2		
C4	137794-8		1	C: 2000μF, 15V		
C5	138501-8		1	C: 500pF, 1000V		
C6	138499-8		2	C: 100pF, 1000V		
C7				Same as C6		
C8	138500-8		1	C: 0.05μF, 500V		
C9	138498-8		4	C: 10μF, 20V		
C10				Same as C9		
C11				Same as C9		
C12				Same as C9		
C13	141905-8		1	C: 0.01μF, 1000V		
A5A1CR1	138502-8		2	Diode: IN2482		
CR2				Same as CR1		
CR3	137808-8		2	Diode: IN5234		
CR4				Same as CR3		
CR5	137797-8		1	Diode: VE-48		
CR6	137798-8		1	Diode: VE-18		
A5A1IC1	137799-8		4	Integrated Circuit: μA723		
IC2				Same as IC1		
IC3				Same as IC1		
IC4				Same as IC1		

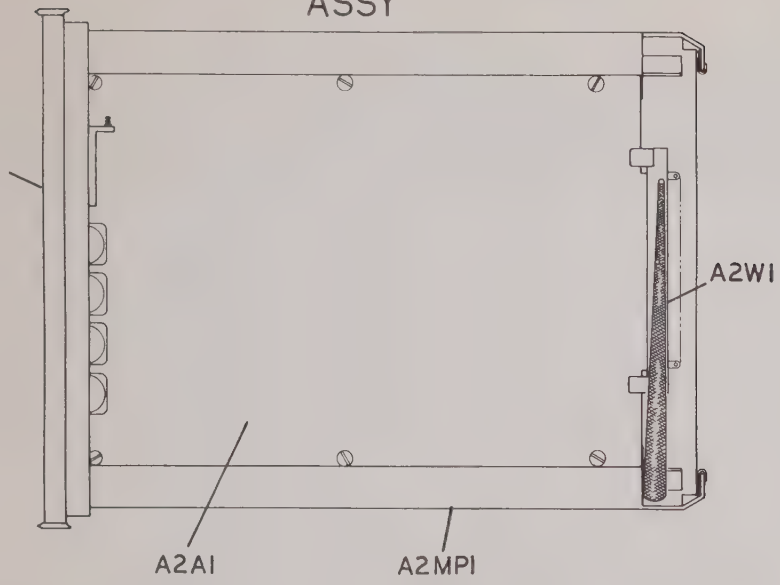
Table 6-1. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
A5A1L1	136731-8		2	Inductor: 680μH		
L2				Same as L1		
A5A1Q1	137824-8		1	Transistor: TIP29A		
Q2	137825-8		2	Transistor: TIP30A		
	137045-8		3	Heat Sink: Part of Q1, Q2, and Q4		
Q3	136752-8		2	Transistor: 2N3905		
Q4				Same as Q2		
Q5				Same as Q3		
Q6	137785-8		1	Transistor: 2N1168		
	138389-8		1	Heat Sink: Part of Q6		
A5A1R1	129817-8		1	R: 33Ω CC, 1/2W, 5%		
R2	129915-8		1	R: 390K CC, 1/2W, 5%		
R3	129860-8		3	R: 2K CC, 1/2W, 5%		
R4				Same as R3		
R5				Same as R3		
R6	138495-8		1	R: 4.3Ω CC, 1/2W, 5%		
R7	129805-8		1	R: 10Ω CC, 1/2W, 5%		
R8	137792-8		1	R: 0.7Ω CC, 1/2W, 5%		
R9	138497-8		1	R: 6.8Ω CC, 1/2W, 5%		
R10	138719-8		1	R: 2K FF, 1/8W, 1%		
R11	138757-8		1	R: 4.99K FF, 1/8W, 1%		
R12	138736-8		5	R: 3.01K FF, 1/8W, 1%		
R13	138748-8		1	R: 4.02K FF, 1/8W, 1%		
R14	138740-8		1	R: 3.32K FF, 1/8W, 1%		
R15				Same as R12		
R16				Same as R12		
R17	138698-8		1	R: 1.21K FF, 1/8W, 1%		
R18				Same as R12		
R19				Same as R12		
R20	138694-8		1	R: 1.1K FF, 1/8W, 1%		
R21	138728-8		1	R: 2.49K, 1/8W, 1%		
R22	139554-8		1	R: Variable 500Ω		
A5A1T1	415430-1		1	Transformer :Power		
A5	416176-3		1	Assembly, Portable DC Power Supply		
A5A1	415999-3		1	Assembly, Power Supply PC Board		
A5A2	415589-2		1	Assembly, Panel and Bracket		
A5F1	128588-8		1	Fuse: 1/4 amp AGC		
A5MP1	415909-2		1	Insulator		
A5W1	409549-1		1	A.C. Cable		
A5XF1	131050-8		1	Fuseholder		
A5A1	415999-3		1	Assembly, Power Supply PC Board		
	415998-3		1	PC Board		

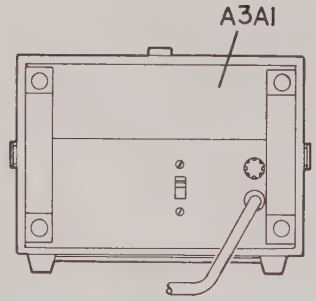
Table 6-1. Replaceable Parts

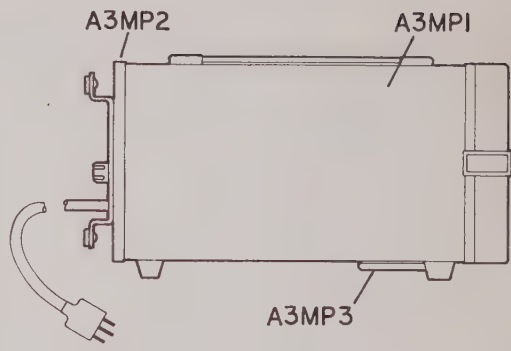
Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
A5A1BT1	138543-8		8	Battery: Ni Cad, 1.25V, Size RR		
BT2				Same as BT1		
BT3				Same as BT1		
BT4				Same as BT1		
BT5				Same as BT1		
BT6				Same as BT1		
BT7				Same as BT1		
BT8				Same as BT1		
A5A1C1	138544-8		2	C: 100μF, 25V		
C2				Same as C1		
C3	138546-8		1	C: 50μF, 25V		
C4	139496-8		1	C: 1000μF, 12V		
C5	137793-8		1	C: 4μF, 250V		
A5A1CR1	137920-8		1	Diode: 1N4001		
CR2	137798-8		1	Diode: VE-18		
CR3	138540-8		2	Diode: SZ12A		
CR4				Same as CR3		
CR5	137797-8		1	Diode: VE-48		
CR6	139495-8		1	Diode IN5232B		
A5A1K1	138541-8		1	Relay		
A5A1MP1	138539-8		16	Battery Clip		
A5A1Q1	137824-8		3	Transistor: TIP 29A		
Q2				Same as Q1		
Q3				Same as Q1		
	137045-8		2	Heat Sink, Part of Q2 and Q3		
A5A1R1	139461-8		1	R: 47Ω, 3.25W, 5%, W.W.		
R2	130129-8		2	R: 47Ω, CC, 1W, 5%		
R3				Same as R2		
R4	129839-8		2	R: 270Ω, CC, 5W, 5%		
R5				Same as R4		
R6	138719-8		1	R: 2K, FF, 1/8W, 1%		
R7	139440-8		1	R: Variable, 2K, 10%		
R8	129853-8		1	R: 1K CC, 1/2W, 5%		
R9	129915-8		1	R: 390K CC, 1/2W, 5%		
R10	138906-8		1	R: 169K, FF, 1/8W, 1%		
R11	129816-8		1	R: 30Ω CC, 1/2W, 5%		
A5A1T1	415950-1		1	Transformer :Power		
T2	415949-1		1	Transformer: I and D		
	416214-1		1	Washer, Part of T2		
				-Miscellaneous-		
	417298-2			Optional Extender Board (for servicing instrument)		

A2 CHASSIS & FRAME ASSY

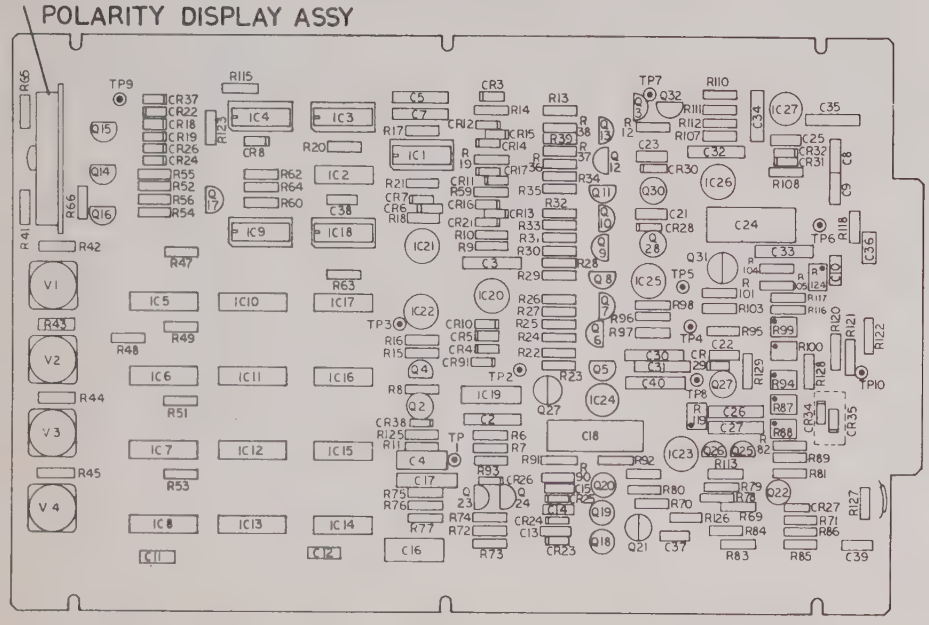


A3 CASE/REAR PANEL ASSY

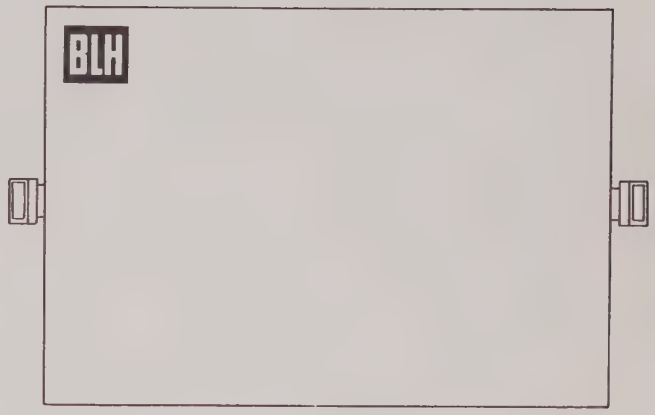




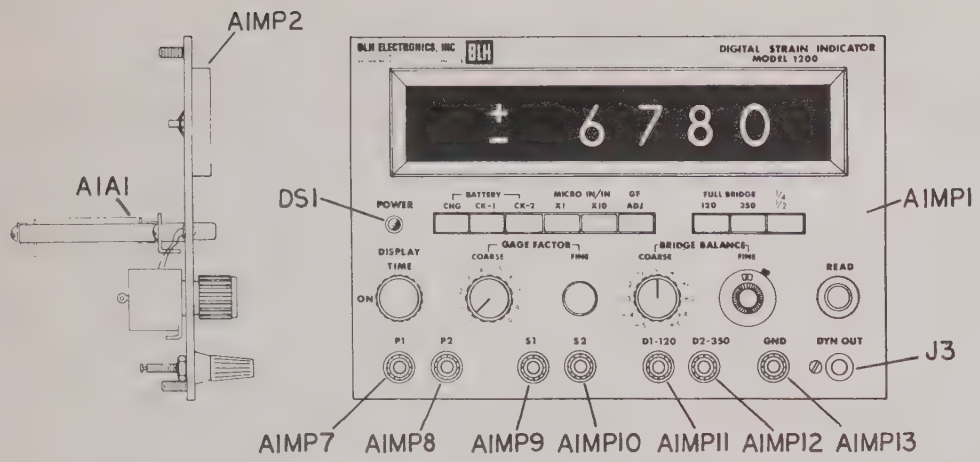
A2A1 PC BOARD ASSY



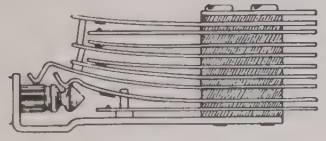
A4 COVER ASSY



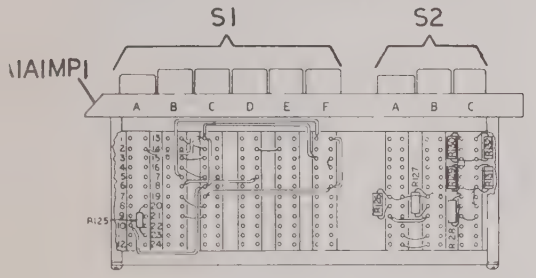
A1 FRONT PANEL ASSEMBLY



of J3 With Plug



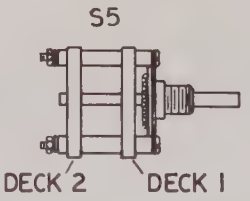
A1A1 FUNCTION SWITCH ASSY



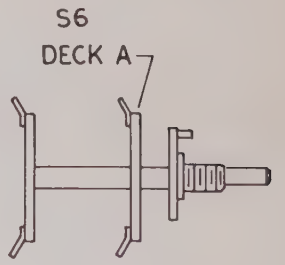
RESISTOR MOUNTING

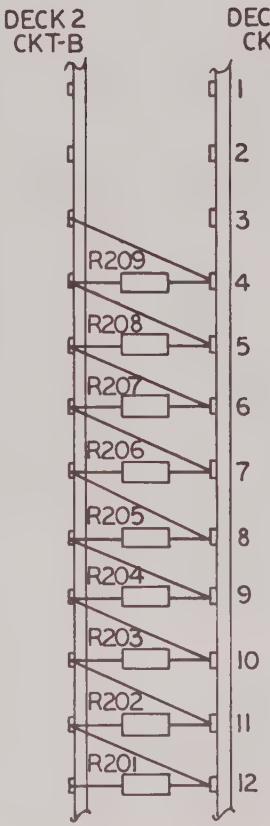
R125 — S1A-20 TO S1A-23
R126 — S2A-7 TO S2A-8
R127 — S2B-7 TO S2B-8
R128 — S2C-7 TO S2C-8
R129 — S2C-4 TO S2C-6
R130 — S2C-1 TO S2C-3
R131 — S2C-16 TO S2C-18
R132 — S2C-13 TO S2C-15

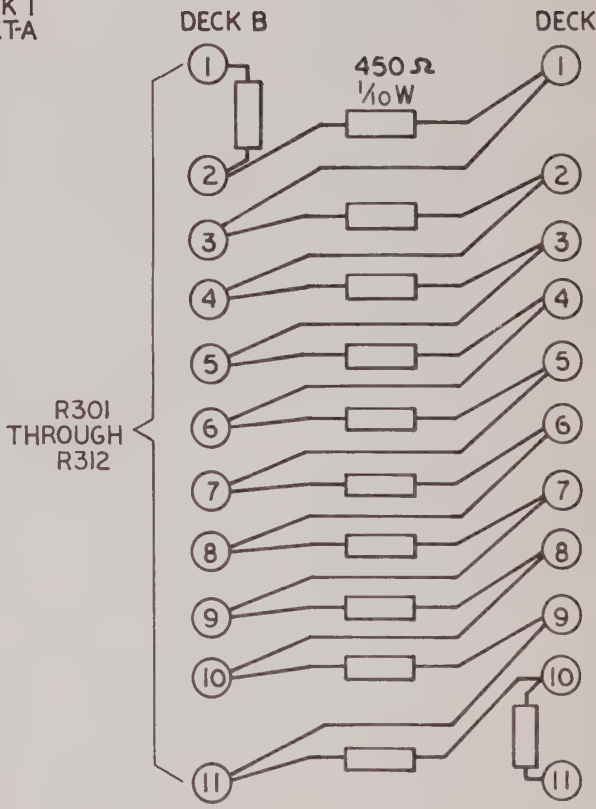
A1A2 GAGE FACTOR SWITCH ASSEMBLY



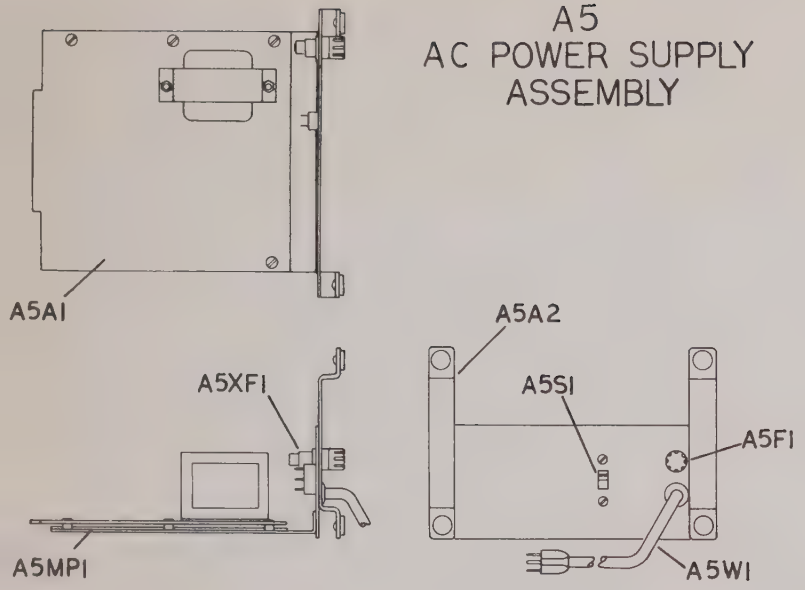
A1A3 COARSE BRIDGE SWITCH ASSEMBLY



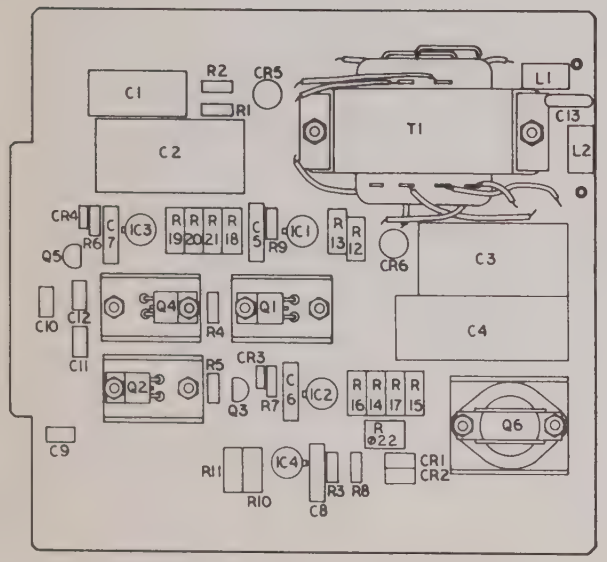




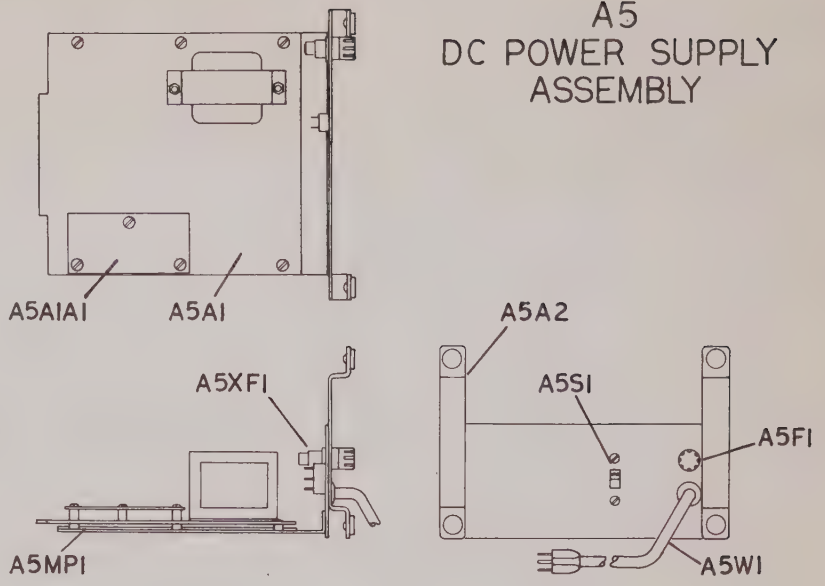
A5
AC POWER SUPPLY ASSEMBLY



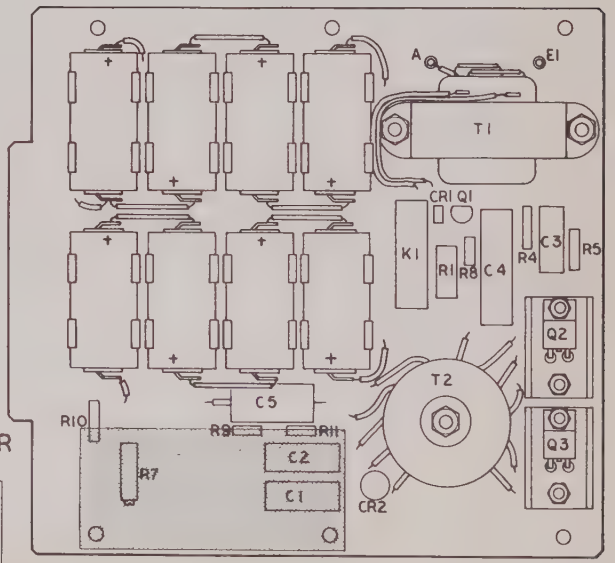
A5A1
PC BOARD ASSEMBLY



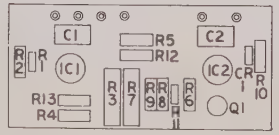
A5
DC POWER SUPPLY ASSEMBLY

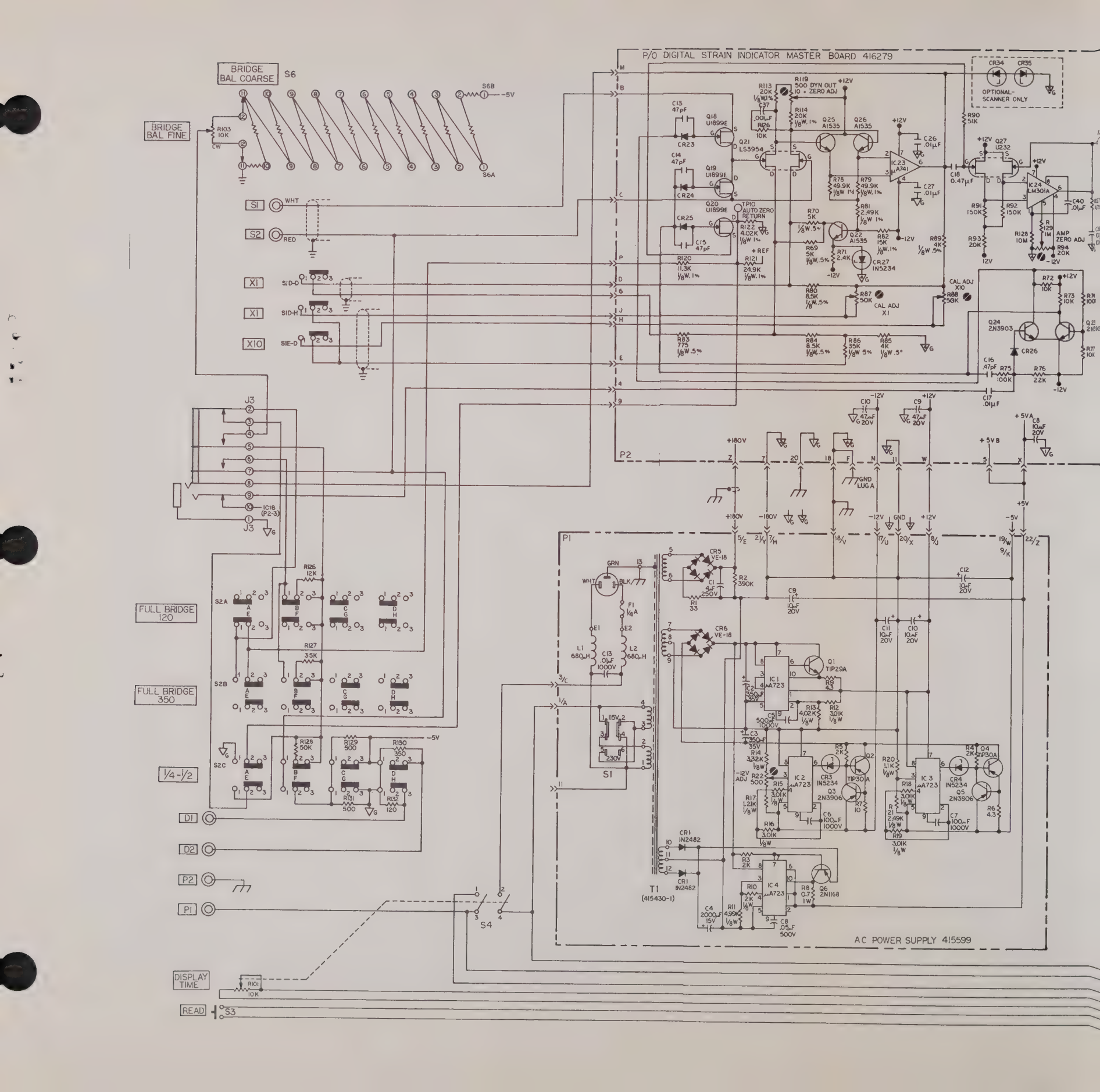


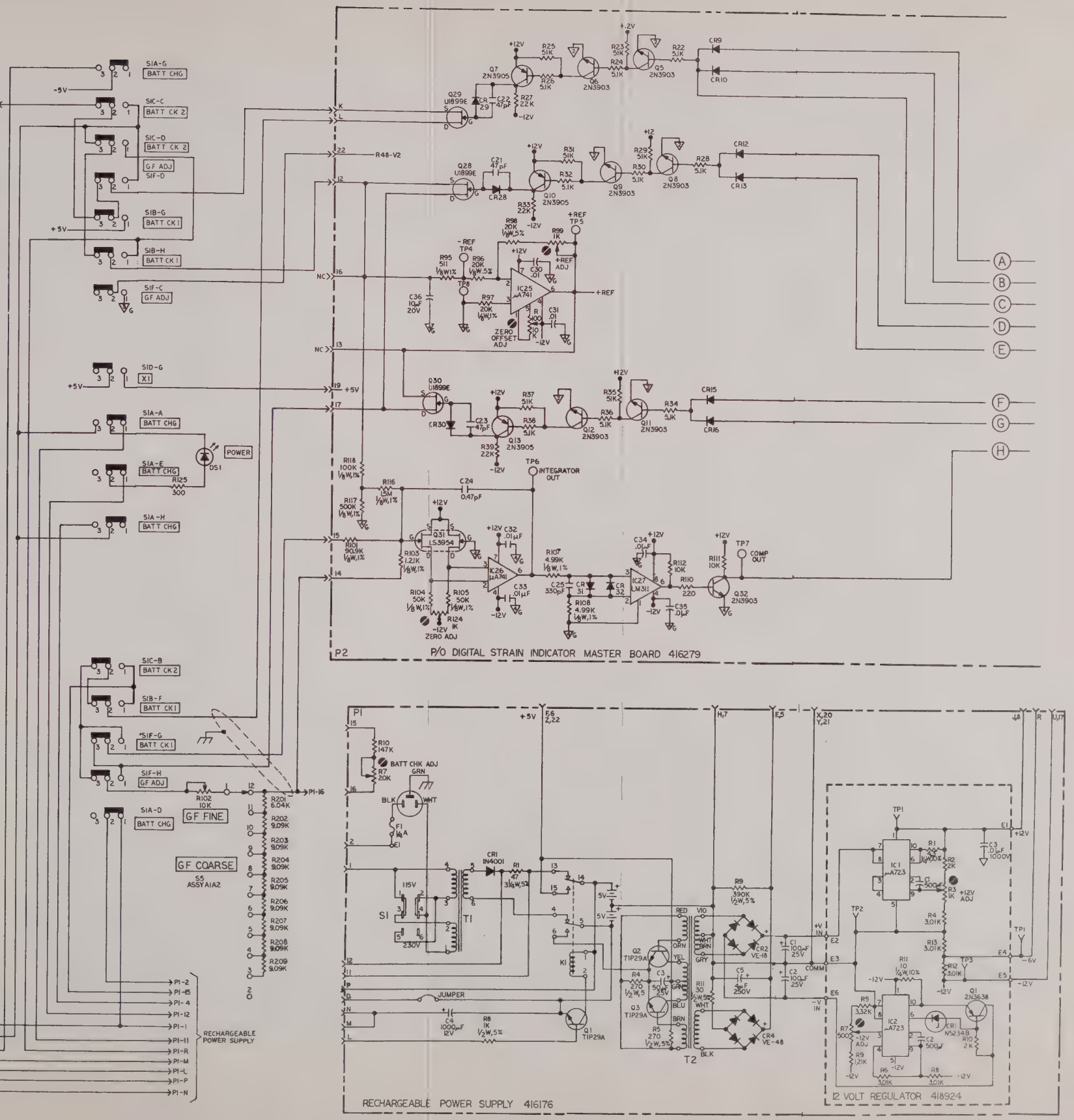
A5A1
PC BOARD ASSEMBLY

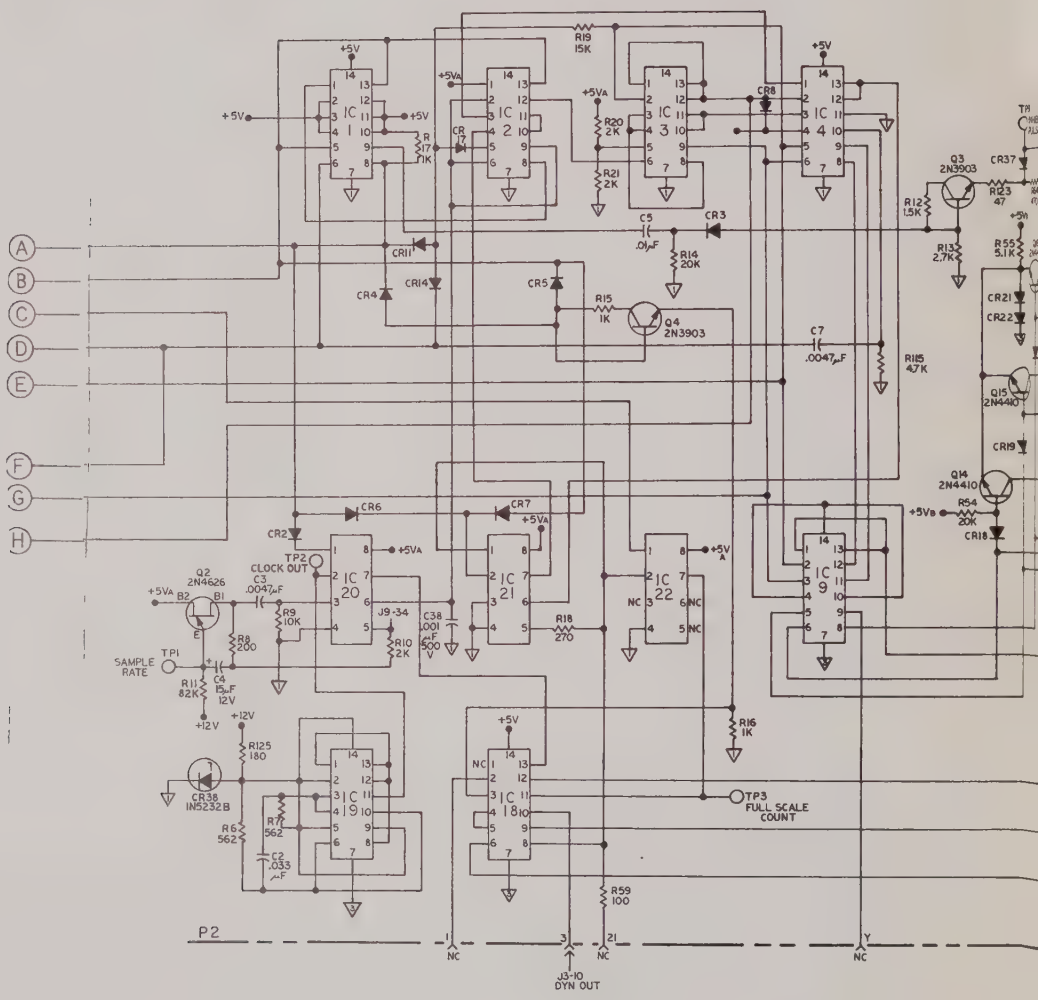


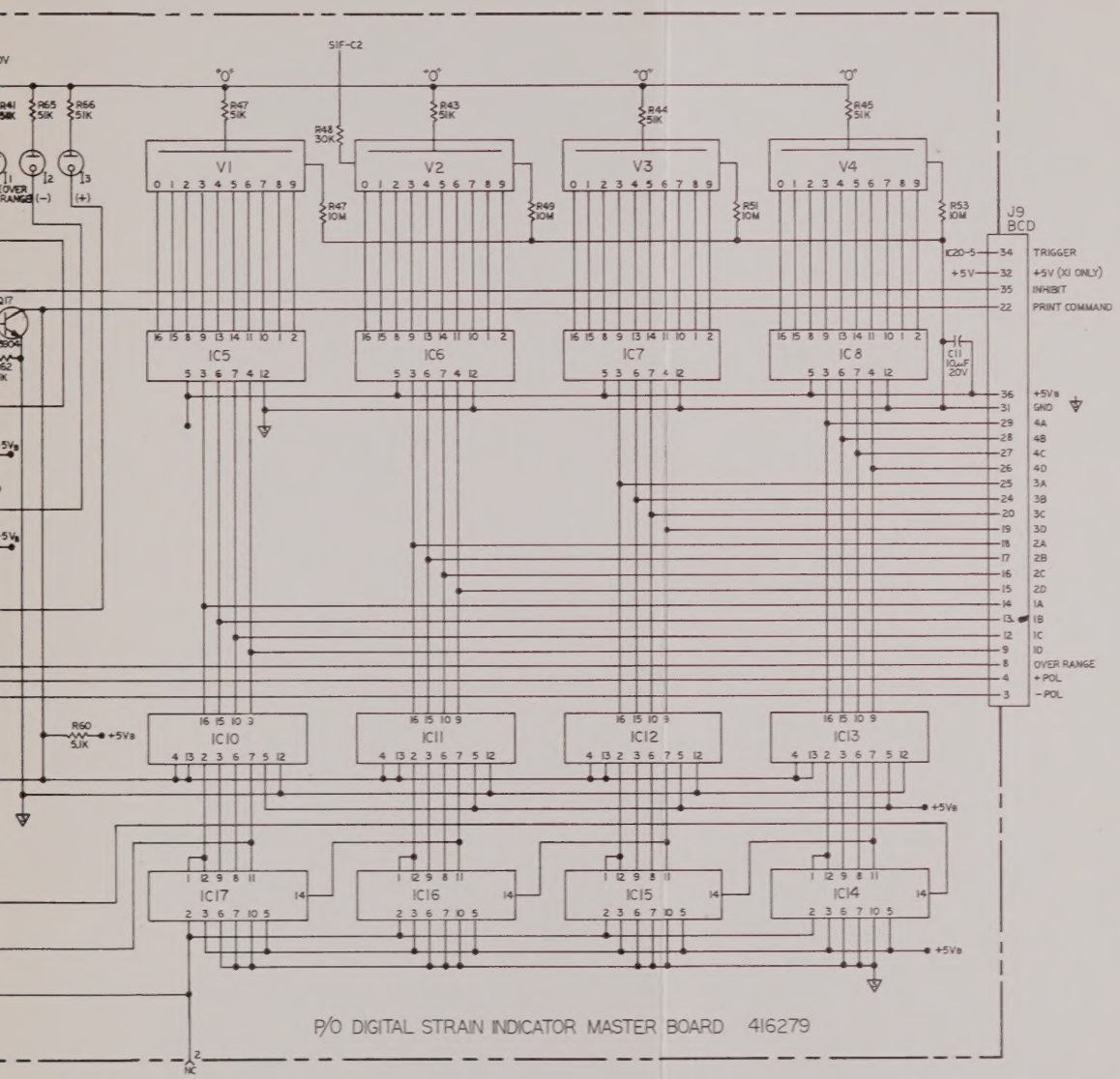
A5A1A1
VOLTAGE REGULATOR

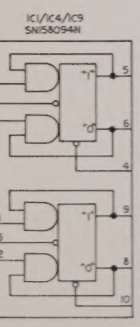


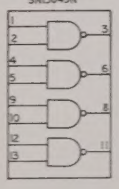

P/O DIGITAL STRAIN INDICATOR MASTER BOARD 416279
BRIDGE BAL COARSE
S6
BRIDGE BAL FINE
R103 10K
CW
S6B
-5V
S6A
S1 WHT
S2 RED
X1 SID-D
X1 SID-H
X10 SIE-D
J3
IC18 (P2-3)
FULL BRIDGE 120
FULL BRIDGE 350
1/4-1/2
S2A
S2B
S2C
R126 12K
R127 35K
R128 50K
R129 500
R130 350
R131 500
R132 120
D1
D2
P2
P1
DISPLAY TIME
R101 10K
READ
S3
S4
OPTIONAL-SCANNER ONLY
CR34
CR35
R119 500 DYN OUT 10 ZERO ADJ
R113 20K
R114 20K
R126 10K
C13 47pF
C14 47pF
C15 47pF
CR23
CR24
CR25
Q18 U1899E
Q19 U1899E
Q20 U1899E
Q21 LS3954
Q25 A1535
Q26 A1535
Q22 A1535
CR27 IN5234
TP10 AUTO ZERO RETURN
R122 4.02K
R120 11.3K
R121 24.9K
+REF
R78 49.9K
R79 49.9K
R81 2.49K
R70 5K
R69 5K
R71 2.4K
R62 15K
R89 4K
R90 51K
R91 150K
R92 150K
R93 20K
R94 20K
R128 10M
AMP ZERO ADJ
C18 0.47µF
C26 .01µF
C27 .01µF
C40 .01µF
IC23 µA741
IC24 LM301A
Q27 U232
R80 8.5K
R83 775
R84 8.5K
R85 4K
R86 35K
R87 50K
CAL ADJ X10
CAL ADJ X1
R88 50K
Q24 2N3903
CR26
R72 10K
R73 10K
R75 100K
R76 22K
C16 47pF
C17 .01µF
P2
+180V
-180V
-12V
GND
+12V
+5V
+5VA
+5VB
GND LUG A
C10 47µF 20V
C9 47µF 20V
C8 10µF 20V
P1
CR5 VE-18
CR6 VE-18
R1 33
C1 4µF 250V
R2 390K
C9 10µF 20V
C12 10µF 20V
C11 10µF 20V
C10 10µF 20V
F1 1/4A
L1 680µH
L2 680µH
C13 .01µF 1000V
S1
115V
230V
T1 (415430-1)
CR1 IN2482
IC1 µA723
IC2 µA723
IC3 µA723
IC4 µA723
Q1 TIP29A
Q2 TIP30A
Q3 2N3906
Q4 TIP30A
Q5 2N3906
Q6 2N1168
CR3 IN5234
CR4 IN5234
C2 350µF 35V
C3 350µF 35V
C4 2000µF 15V
C5 500pF 1000V
C6 100µF 1000V
C7 100µF 1000V
C8 .05µF 500V
R14 3.32K
R15 3.01K
R16 3.01K
R17 1.21K
R18 3.01K
R19 3.01K
R20 1.1K
R22 500
-12V ADJ
AC POWER SUPPLY 415599

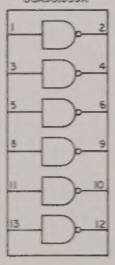

P2
P/O DIGITAL STRAIN INDICATOR MASTER BOARD 416279
P1
RECHARGEABLE POWER SUPPLY 416176
12 VOLT REGULATOR 418924
GF COARSE
S5 ASSY A1A2
GF FINE
POWER
DS1
SIA-G BATT CHG
SIC-C BATT CK 2
SIC-D BATT CK 2
G.F ADJ SIF-D
SIB-G BATT CK1
SIB-H BATT CK1
SIF-C GF ADJ
SID-G X1
SIA-A BATT CHG
SIA-E BATT CHG
SIA-H BATT CHG
SIC-B BATT CK2
SIB-F BATT CK1
SIF-G BATT CK1
SIF-H GF ADJ
SIA-D BATT CHG
R48-V2
+REF
-REF
INTEGRATOR OUT
COMP OUT
ZERO OFFSET ADJ
ZERO ADJ
BATT CHK ADJ
JUMPER
RECHARGEABLE POWER SUPPLY
P1-2
P1-15
P1-4
P1-12
P1-1
P1-11
P1-R
P1-M
P1-L
P1-P
P1-N
P1-16

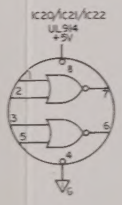

P2
A
B
C
D
E
F
G
H
+5V
+5Va
+12V
R19 15K
R20 2K
R21 2K
R17 1K
R14 20K
R15 1K
R16 1K
R18 270
R9 10K
R10 2K
R8 200
R11 82K
R125 180
R6 562
R7 562
R59 100
C5 .01µF
C7 .0047µF
C3 .0047µF
C4 15µF 12V
C2 .033µF
C38 .001µF 500V
CR1
CR2
CR3
CR4
CR5
CR6
CR7
CR8
CR37
CR38 1N5232B
Q2 2N4626
Q3 2N3903
Q4 2N3903
Q14 2N4410
Q15 2N4410
R12 1.5K
R13 2.7K
R23 47
R55 5.1K
R54 20K
R185 4.7K
TP1 SAMPLE RATE
TP2 CLOCK OUT
TP3 FULL SCALE COUNT
J9-34
J3-10 DYN OUT
NC
IC 1
IC 2
IC 3
IC 4
IC 9
IC 18
IC 19
IC 20
IC 21
IC 22











MODEL 1200
SCHEMATIC

MP MASTER
MA24949